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WOUNDS OF THE HEART

AND A DISCUSSION OF THE CAUSES OF DEATH*

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INTEREST has been aroused and a study of this subject has been stimulated by two recent heart wounds which have come under our care. These cases having been different, each has furnished an illustration of what we consider valuable facts pertaining to this most important subject. So the contents of this paper will be formed around these case reports.

In discussing the causes of death we will not consider wounds of the bundle of His or massive wounds of the heart causing sudden, and almost instantaneous death. Such conditions, of course, would require little attention because there is no possible remedy that might be used to save life. Therefore, we can readily state that the preventable causes of death from heart wounds might be given as follows:

1. "*Herz tamponade*" has proved to be one of the most common causes.

2. *Foreign bodies in the heart and pericardium* may be considered as a less important cause of death.

3. *Hemorrhage* occupies probably a place before that of "Herz tamponade."

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4. *Infection.* Should the patient survive after a heart wound the chances of him dying from infection, most often pleural, are very great. It is to these causes that we shall direct our remarks, and at the same time report cases illustrating them.

In the John Sealy Hospital, Galveston, over a period of twenty years, 10 cases of wounds of the heart have been treated[1]:

TABLE 1

WOUNDS OF HEART TREATED IN THE JOHN SEALY HOSPITAL

Seven Stab Wounds

Location	*Result and Cause of Death*
5 Cases Operated Upon.	
1. Wound in auriculoventricular septum. Chest full of blood	Died on operating table from hemorrhage
2. Wound in right ventricle	Died on operating table from hemorrhage
3. Wound in left ventricle	Died five hours after operation from hemorrhage
4. Wound in interventricular septum, anteriorly	Lived forty-five days after operation and died from suppurative empyema
5. Wound in left ventricle	Recovered following suture
6. Stab wound of apex of heart	Died five days later from fibrinopurulent pericarditis and pleurisy
7. Stab wound in left ventricle (stabbed about two hours previous to entrance to hospital. Wound examined and found to have a very small entrance in left ventricle. Pericardial sac filled with blood clot and only small amount of bleeding from wound in chest wall)	Died on operating table from "Herz tamponade"

Three Gunshot Wounds

None Operated Upon.	
8. Bullet wound through left ventricular wall	Died eleven days later from pneumonia, pericarditis and delirium tremens
9. Wound through pericardium. Great shock. Wound in front and behind indicated bullet hit heart (Injury in 1927)	Recovered and left hospital forty-eight hours later against advice (well in 1932)
10. Shot lodged in right ventricle (Injury in 1930)	Recovered following aspiration (well in 1932)

CASE 1. (Hosp. Rec. No. 987.) A. W., male, colored, twenty-two years of age, with a stab in left side of chest. He was operated upon twelve hours after being wounded. The left pleural cavity was found filled with blood. A stab wound was in left ventricle. He died on the operating table. The cause of death was hemorrhage and shock. Operator, Dr. J. E. Thompson.

CASE II. (Hosp. Rec. No. 40769.) M. J., male, colored, thirty years of age, had a large stab wound in right auricle. He was operated upon within two hours from the time of injury. He died upon the operating table of

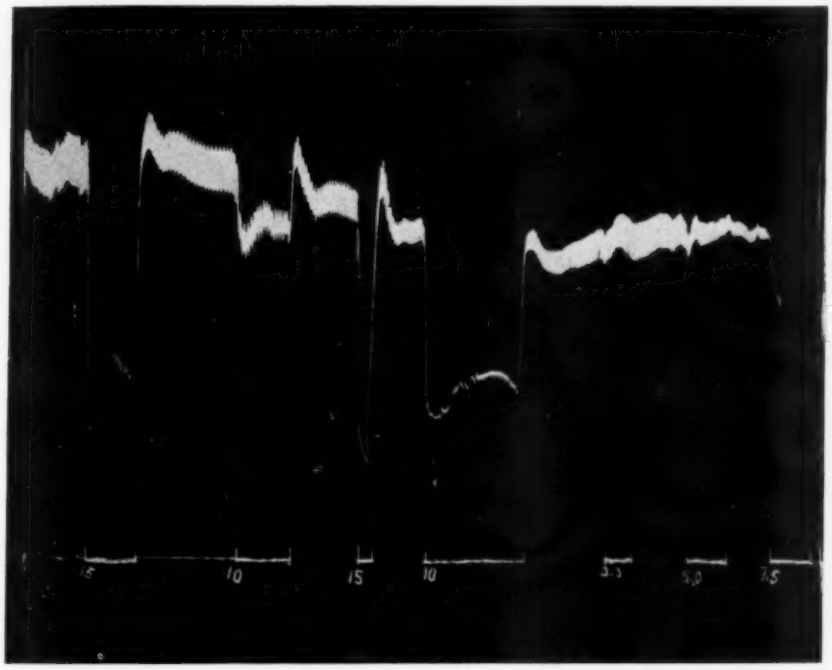

FIG. 1. Cannula was tied into cat's pericardial sac and connected with a water bottle. By raising bottle any desired pressure could be applied within pericardium. Record shows constant tracing of carotid arterial pressure throughout a twenty-minute period during which varying intrapericardial pressures were applied as indicated in base line. Application of any considerable pressure caused an immediate drop in arterial pressure; after intracardial pressure was released arterial pressure promptly returned to its previous level. Blood pressure was as high at end of period as at beginning, demonstrating ability of heart to recover after release of "tamponade."

hemorrhage. Operator, Dr. G. W. N. Eggers.

CASE III. (Hosp. Rec. No. 31.) M. McK., male, colored, thirty-three years of age, had a stab wound in the left ventricle. He was operated upon about five hours after being wounded. His left pleural cavity was filled with blood. The heart was sutured. The patient died of shock and hemorrhage five hours after operation. Operator, Dr. H. R. Dudgeon.

CASE IV. (Hosp. Rec. No. 1236.) H. B., male, white, twenty-six years of age. He was operated upon a few hours after a stab wound of the heart. The left pleural cavity was filled with blood. The heart wound was in the ventricular septum. It was sutured. The patient lived forty-six days and

died of empyema. An autopsy showed the heart in good condition. Operator, Dr. H. R. Dudgeon.

CASE V. (Hosp. Rec. No. 182048.) P. R., a Mexican boy, twenty-one years

FIG. 2. *X*-ray film made before aspiration showing enormous distention of pericardium with blood.

of age, received a stab wound in the left chest, pericardium and heart. The wound in heart was sutured six hours after being wounded. The chest was filled with blood, and a blood clot in the pericardial cavity. The wound was sutured and the patient recovered. (A more complete history is given elsewhere.) Operator, Dr. A. O. Singleton.

CASE VI. (Hosp. Rec. No. 172932.) J. A., female, colored, twenty-nine years of age, had a stab wound in left chest which entered the heart. The wound of the heart was not recognized. There was extreme hemorrhage into the pleural cavity. She died four days later from hemorrhage, shock,

fibrinopurulent pericarditis and pleurisy, as revealed by autopsy. Operator, Dr. H. Williams.

CASE VII. This was a Marine patient who was stabbed two hours

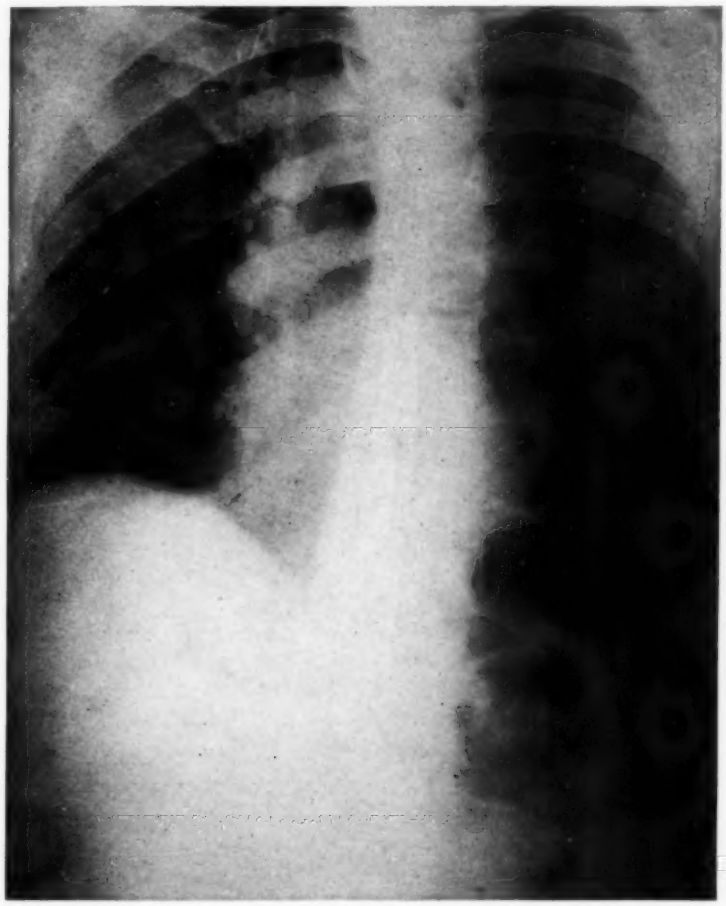

FIG. 3. Pericardium much reduced in size following aspiration. Shot is also shown imbedded in right ventricle.

previous to entering the hospital. An operation revealed a small wound in the left ventricle. The pericardial sac was filled with blood and clot. He died before operation could begin of "Herz tamponade." Operator, Dr. N. Andronis.

CASE VIII. (Hosp. Rec. No. 10037.) G. S., male, white, fifty-one years of age, had a gunshot wound through the left ventricle. Hemothorax was marked. He was not operated upon. He died twelve days later from pneumonia, pericarditis and delirium tremens. The wound of the heart was not recognized before autopsy.

CASE IX. (Hosp. Rec. No. 155494.) M. S., female, white, aged thirty, received a gunshot wound. The wound of entrance was 2 inches to the left of the sternum in the fourth interspace. The wound of exit was directly

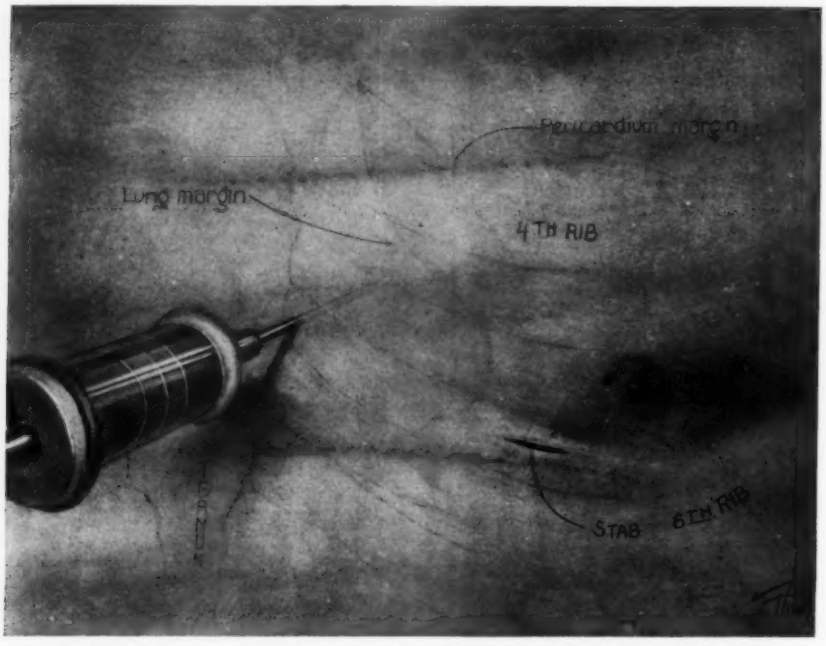

FIG. 4. Drawing of chest showing wound and process of aspiration of pericardium.

behind. The patient showed great shock and refused operation. She left the hospital without permission three days later, much improved. She finally had a complete recovery. This was apparently a bullet wound which went through the pericardium, possibly wounding the heart. Recovered without operation.

CASE X. (Hosp. Rec. No. 162132.) E. W., male, colored, aged thirty-eight, was in the hospital in 1929 with a stab wound in the chest and recovered without operation. In 1930 he entered the hospital with a gunshot wound of the pericardium. "Herz tamponade" was evident. The shot lodged in the right ventricle. He recovered following aspiration of the pericardium. A complete history of this case is given elsewhere.

I. "HERZ TAMPONADE"

Since "Herz tamponade" is a common cause of death in wounds of the heart, we wish at this time to refer to two of the foregoing cases which illustrate this phenomenon.

CASE VII. This patient reached the operating room two hours after being stabbed. He was in great distress, much shock, cyanosed and pulseless, blood pressure being very low and he died on the operating table

FIG. 5. Incision opening chest in fifth intercostal space with excision of stab wound.

before the operation could be started. The pericardium was distended with blood, little blood having been lost externally. This patient evidently died of "Herz tamponade." Had such been recognized and the pressure within the pericardium relieved by aspiration, his condition would have been improved and an operation for suture would have been possible.

CASE X. "A colored man was admitted to the surgical ward of the John Sealy Hospital, about twenty hours after having been shot with a shotgun at considerable distance, so that several small puncture wounds were visible on the anterior chest wall. Two of these wounds were in the heart area. The patient was in great distress, cyanosed, dyspneic and the pulse rapid and weak. A physical examination revealed a large cardiac area and *x*-ray films corroborated a diagnosis of pericardial distention. His condition appeared so grave, and apparently due to 'Herz tamponade,' that aspiration of the pericardium was immediately done, and 250 c.c. of bloody fluid were withdrawn. The result was magical. The patient at once became tranquil, felt comfortable and his respiration and circulation

returned to normal. Two days later some further accumulation of fluid occurred as revealed by the *x*-ray. The fluid, not great in amount, was subsequently absorbed. *X*-ray plates and fluoroscopic examination revealed

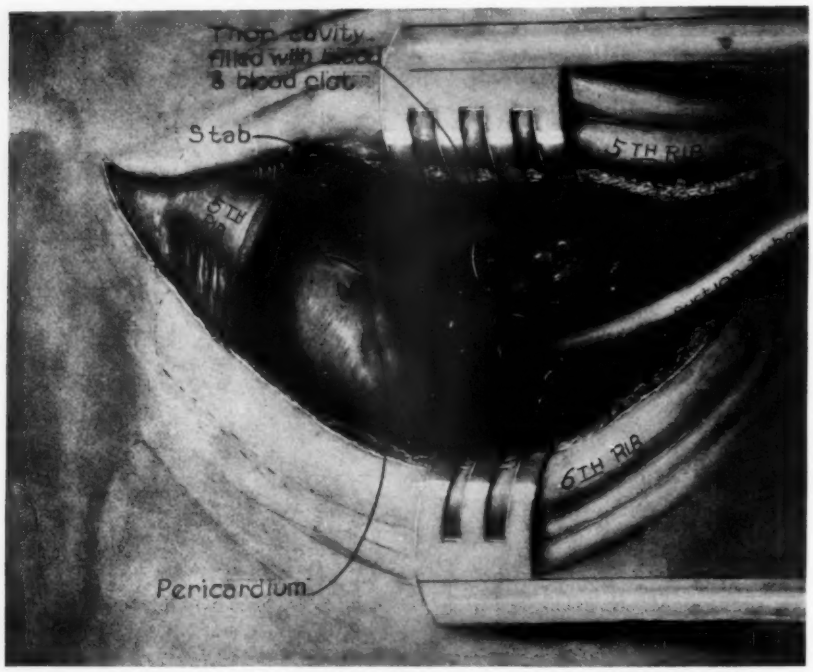

FIG. 6. Chest is opened and ribs retracted. Pleural cavity is found filled with blood and blood clots. Lung is collapsed and blood is flowing from wound in pericardium.

a No. 6 shot within the heart muscle, apparently in the right ventricular wall. Within a short time his recovery was apparently complete with no evidence of cardiac disturbance, either by physical examination or electrocardiographic tracings. The shot may now be seen fluoroscopically moving with the contraction of the heart."[1] (Figs. 3–5.)

Without prompt relief by aspiration this patient would have died from heart compression. Morgagni in 1776 stressed the danger from compression of the heart from hemorrhage into the pericardium, and one hundred years later Rose termed this phenomenon "Herz tamponade." A simple experiment will demonstrate this condition. If a cannula is tied to an animal's pericardial sac and connected with a water bottle; raising of the water bottle causes a rise of pressure within the pericardium with a corresponding drop in arterial pressure, but if the inter-

pericardial pressure is relieved the arterial pressure promptly rises. Therefore, when a wound of the heart occurs in which the hemorrhage cannot escape readily from the pericardium,

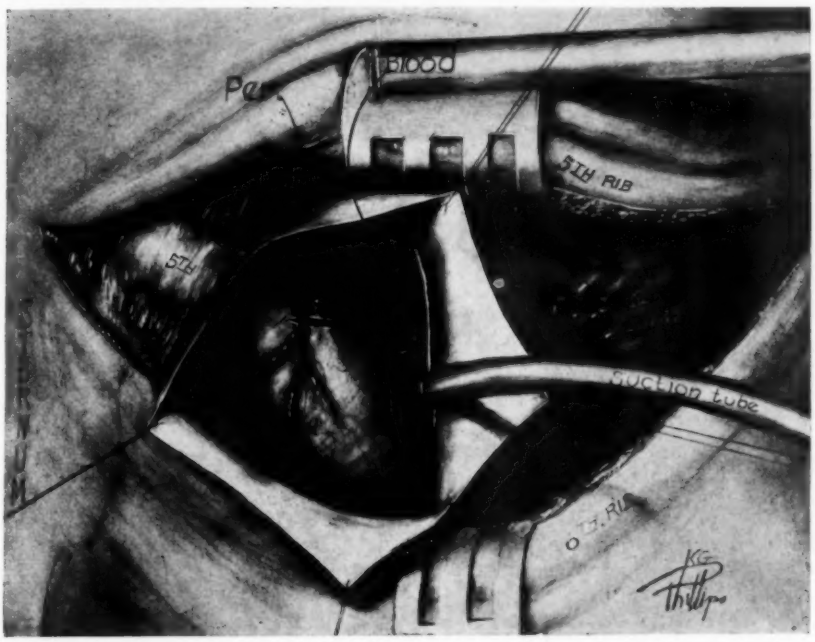

FIG. 7. Pericardium is opened and blood clots removed from beneath pericardium with suction. Wound is seen near ventricular septum across interventricular branch of left coronary artery.

death will result when the interpericardial pressure equals that within the heart cavities. (Figs. 6–7.)

An examination of the literature reveals that aspiration of the heart has been done before for the relief of heart compression from hemorrhage. Cox[2] reports the repeated aspiration of the heart after suture when symptoms of compression persisted, and from 100 to 200 c.c. of fluid were removed every few days for five aspirations, and the patient finally recovered. Dr. F. Beekman of New York, in a recent communication, states that he relieved a patient with a heart wound by aspiration of 100 c.c. of blood from the pericardium before heart suture, and the patient recovered.

On the other hand, aspiration of the pericardium is criticized as an unsafe procedure by many. We do not believe that aspiration of the pericardium is always unwise; on the contrary with

FIG. 8. Control stitch is put through apex of heart. Wound in heart is sutured with interrupted silk suture.

definite signs and symptoms of effusion, and with reasonable care, one need not hesitate to puncture the pericardium. The diagnosis of suppurative pericarditis is confirmed by aspiration; and, incidentally, the number of recoveries following drainage is rapidly increasing. Also many reports of pericardial drainage indicate that distressing symptoms caused by interpericardial pressure are immediately relieved. Therefore, we are of the

opinion that prevention or relief of "Herz tamponade" will save life in a certain number of heart injuries. This may be done for temporary relief, giving time for operative intervention in some cases, and occasionally aspiration alone may result in recovery as in the case reported.

2. FOREIGN BODIES IN THE HEART AS A CAUSE OF DEATH

The influence of a foreign body in the heart or pericardium must be considered as a cause of death, and an examination of the cases reported from the literature shows a surprising number of patients little the worse because of the presence of the foreign body. We have been able to collect from the literature, and including our own case, 86 cases of foreign bodies in the heart.[1] (Fig. 8.)

TABLE II

Number of cases	86
Deaths all causes	17
Percentage of mortality	19.7
Number of operations	33
Deaths, operative	4
Cases, non-operative	49
Deaths, non-operative	5
Deaths from other causes	8
Cases found incidental to autopsy	4

Of these 17 patients died, a mortality of 19.7 per cent; 33 were operated upon for the removal of the foreign body and 4 of these died. Forty-nine patients were not operated upon, and of these 5 died. Deaths from other causes, not attributable to the foreign body, were eight. Therefore, a foreign body in the heart is not always fatal and an operation for the removal may be increasing the danger more than allowing the foreign body to remain. This would indicate that removal of a foreign body from the heart should be attempted only after very careful consideration.

3. HEMORRHAGE AS A CAUSE OF DEATH

Loss of blood will cause death in a considerable number of heart wounds. With large wounds communicating with the

cavity of the heart, the loss of blood will be rapid, but often the wound is of such a nature that the flow of blood will be sufficiently slow that a number of hours may elapse before death occurs. Death from hemorrhage with few exceptions occurs in those cases where in addition to heart wounds there is also an opening between the pericardium and the thoracic cavity; in this event "Herz tamponade" does not kill the patient because the blood escapes into the pleural cavity relieving the interpericardial pressure and the patient dies from a concealed hemorrhage. When one considers the very small area of pericardial attachment to the anterior chest wall, it is evident that in wounds of the heart, more often than not, the bullet or knife passes through the pleural cavity and then through the pericardium. The hemothorax which follows complicates the condition.

4. INFECTION AS A CAUSE OF DEATH

Also, it will be seen that a secondary complication, that of infection, may cause death should the patient not die from hemorrhage. Because of this added complication one should anticipate and try to determine its presence before treatment is instigated. I mean by this that if the pleura has not been wounded great care should be used to avoid opening it in approaching the heart in an operative way. On the contrary, if the pleura is wounded operative procedure should be undertaken, not only with the idea of suturing the wound in the heart but also with the idea of preventing empyema. Many have had the experience of satisfactorily suturing heart wounds and having the patient die later of infection, usually empyema.

The position of the external wound and the physical signs of hemothorax with faint and distant heart sounds, and the signs and symptoms of hemorrhage usually make the diagnosis fairly sure. The operative approach in such a case is transpleural. Also, in order to anticipate the empyema a most painstaking effort should be made to eliminate infection. The infectious bacteria will have been carried into the tissues by the

instrument causing the wound, and the greater number of bacteria will be in the wound in the chest wall, and the remainder in the blood within the chest cavity. Therefore,

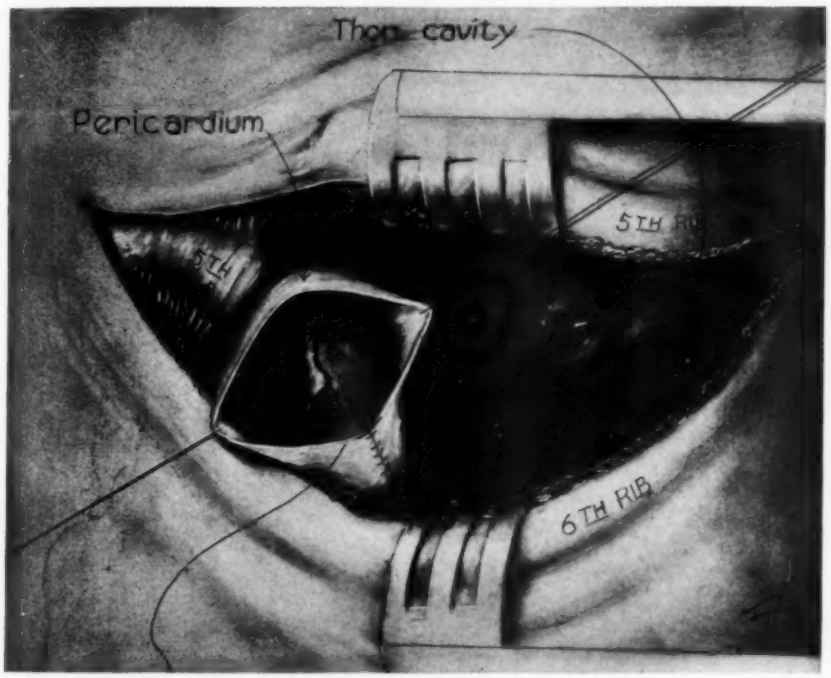

FIG. 9. Pericardium is aspirated dry and closed with a continuous silk suture. Blood clots are removed from chest and pleural cavity is sucked dry.

debridement of the wound should be carefully done and the blood from the chest cavity completely removed with the idea of eliminating infection. In this way, one should have an almost aseptic operation. Since stab wounds are much more highly infectious than bullet wounds, the former should be extremely carefully treated in the way just suggested.

Case IV illustrates an example of a successful suture of the heart, the patient dying forty-five days later from empyema. This might have been prevented by a more careful antiseptic technique.

Also, Case V illustrates a type of heart wound from which the patient might have died of hemorrhage or subsequently from infection. This case is given in detail here to illustrate the operative technique.

CASE V. On November 14, at 3 A.M., a Mexican boy, aged twenty-one, received a stab wound. He was seen in the hospital six hours later, at which time an examination revealed a wound the width of a knife blade, just

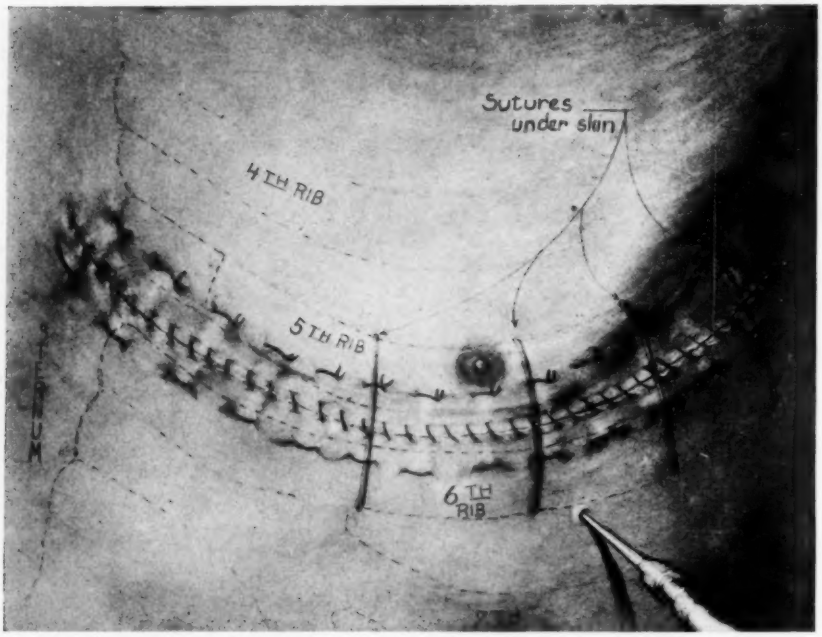

FIG. 10. Chest wall closed with interrupted catgut sutures encircling adjacent ribs. Skin is closed with silkworm gut and chest aspirated free of air causing lung to expand before patient leaves operating table.

below the nipple on the left side of the fifth intercostal space. He was restless, tossing about, pale, thirsty, with all the evidence of a serious hemorrhage. The left side of his chest was dull throughout. The heart sounds were distant and faint and the heart beat rapid. A heart wound was suspected. The pericardium was aspirated and a small amount of blood recovered. A heart wound was evident and he was immediately operated upon. The skin was cleansed carefully, disinfected and the wound excised. Under local anesthesia the chest was opened through the fifth intercostal space, the fifth cartilage was cut near the sternum and the ribs spread apart. The left thoracic cavity was filled with blood which flowed out freely. An opening was seen in the pericardium. The chest cavity was completely emptied of blood clots and blood by the hand and suction. The pericardium was slit open and a stab wound of the heart was seen. Its location was just over and to the left of the interventricular septum and across the interventicular branch of the left coronary vessels just distal to the bifurcation of the left coronary artery. A probe was inserted which entered the left

ventricle. A traction stitch of silk was placed through the apex of the heart as advised by Beck and put into the hand of an assistant. At the signal to tighten, the heart was steadied and a silk suture passed through the wound,

FIG. 11. Patient after recovery, showing scar of operative wound.

then the heart was released, and the stitch tied. This was repeated for the placing of three stitches, requiring only a very short time. A fair-sized blood clot was aspirated from the pericardium just beneath the heart. No sponging was done within the pericardium or pleural cavity. The pericardial sac was closed with a continuous silk suture. The chest wall was closed by interrupted catgut stitches about the adjacent ribs. The skin was closed with silkworm gut. No drainage was used. A large needle attached to a suction apparatus was inserted between the ribs above the wound, and with suction and forced inflation, the lung rapidly expanded, and the lung could be felt touching the needle. (Figs. 9–13.)

Following the operation 500 c.c. of blood were transfused. The patient's convalescence was almost uninterrupted. A troublesome cough lasted for four days, temperature rose to 102°F., then dropped to normal within

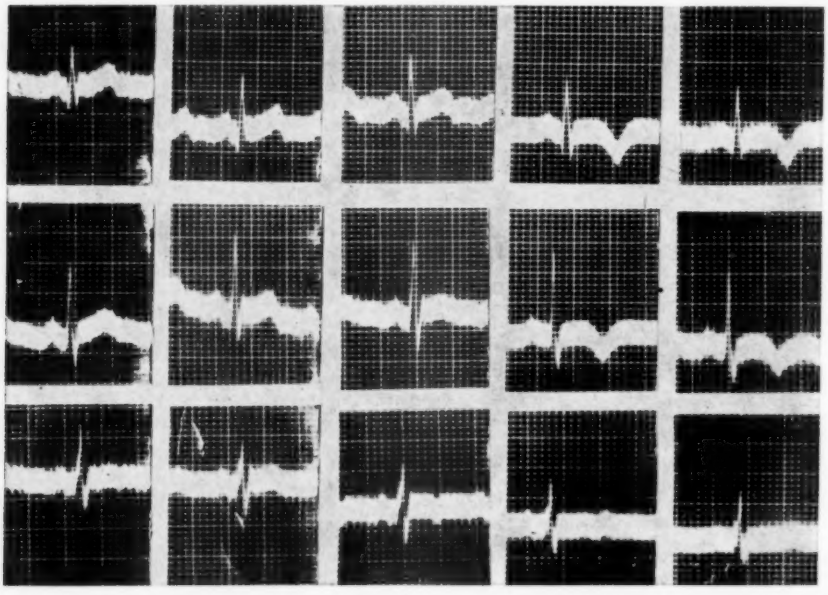

FIG. 12. Electrocardiograms taken following operation upon successive dates. Three usual leads are shown. Significant changes in first three curves are elevation of S-T intervals above isoelectric levels. This change becomes slightly more marked on successive days. On third day, T wave inversion in Lead III appears. Seventeen days later T waves in all three leads are inverted, and in Leads I and II, where it is especially marked, they are preceded by an upward convexity of the S-T interval (coronary T waves). Ten days later curves are identical with exception that T III has become upright. Changes, both early and late, are essentially same as those seen in coronary thrombosis. In addition, similar changes to those shown in first three curves are seen in pericardial effusion.

seven days, with complete recovery.

(Consultation of Dr. Edw. H. Schwab, from the Department of Cardiography, Medical Department, University of Texas, Dec. 5, 1932): "The physical examination of the heart at present is essentially negative. There is no cardiac enlargement present and with the exception of a soft blowing systolic murmur at the pulmonic area, which is of no significance, no adventitious sounds are heard. The heart sounds are of good quality.

"The early electrocardiograms show changes (elevation of the S-T intervals) similar to those encountered in patients studied shortly after a coronary thrombosis. The later curves defecting marked T wave negatively preceded by upward convexity of the S-T intervals (coronary T waves)

are identical with those obtained late in the course of a coronary thrombosis, where the infarct has resulted from an obstruction in the anterior descending branch of the left coronary artery itself, or some of its larger branches.

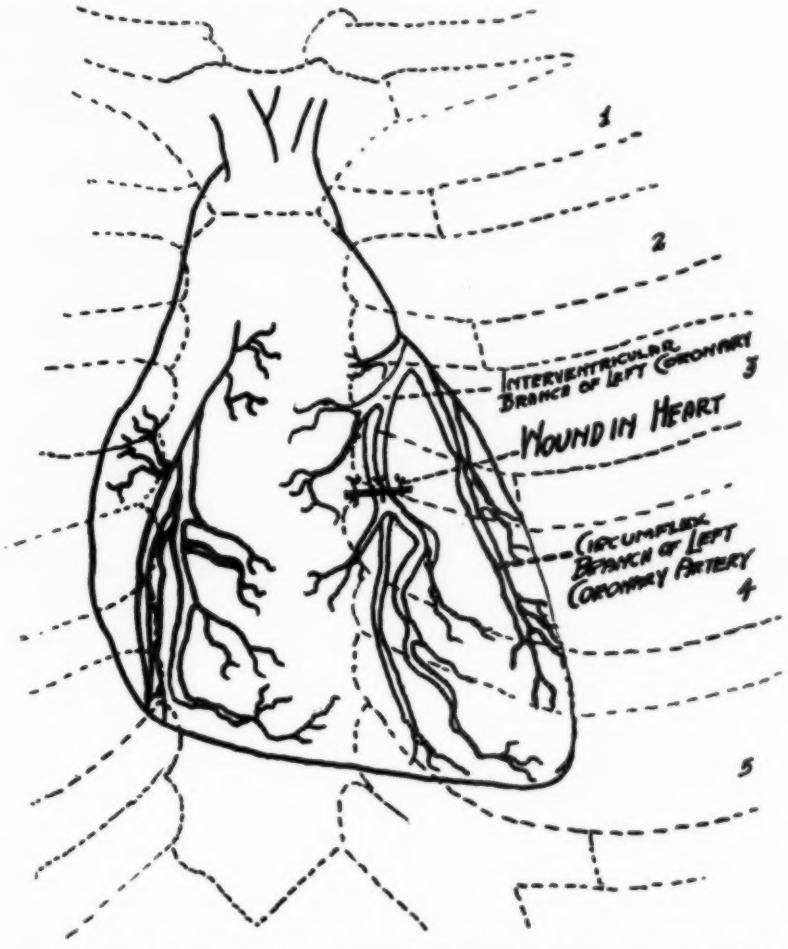

FIG. 13.Drawing showing wound severing branch of left coronary artery.

Unfortunately, due to the patient's condition which prevented moving to the Heart Station, curves were not obtained between these two periods."

Observations: Though a large branch of the coronary artery was occluded, there was apparently not the pain at any time which one would expect from the ordinary coronary occlusion. During the heart suture, which was done under local anesthesia, there was no evidence of pain from the heart sutur-

ing, though it was noted that the heart was thrown into violent contraction with each puncture of the suture needle. These observations have been made by others. The limits of this paper will not permit of the discussion of this phase of the subject. Porter and Bigger[3] have recently published some interesting findings along these lines.

SUMMARY

1. The important causes of death from heart wounds which we should remember are:

"Herz tamponade"
Hemorrhage
Foreign bodies
Secondary infection.

2. Aspiration of the pericardium may relieve the patient from "Herz tamponade" temporarily until the operation can be performed, and occasionally aspiration alone may save life.

3. Foreign bodies may do little harm and should not be removed in most instances.

4. Extreme care should be used to eliminate infection, which often follows in the pleural cavity, and takes many lives after apparently successful suture.

5. The operative approach to the heart when the pleura has not been injured should be with great care to avoid opening the pleura. On the other hand when the pleura has been wounded the approach should be through the pleural cavity.

6. Electrocardiographic studies were given which showed the effect of the coronary obstruction.

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DISCUSSION ON PAPERS OF DR. MASON AND DR. SINGLETON*

DR. DANIEL C. ELKIN, Atlanta, Ga. Dr. Singleton's experience with cardiac suture is indeed remarkable since the opportunity of performing this operation comes to only a few surgeons. I was interested in his statement that when coronary vessels were tied there was no pain simulating that of coronary occlusion or of angina pectoris. I reported a like instance two years ago in which there was an absence of typical coronary pain. The character of the pain, however, is difficult to judge since there is usually considerable pain in the chest as a result of the operation.

I believe that a cardiac tamponade can usually be diagnosed, but if there is doubt as to whether or not injury of the heart exists it is better to do an exploratory pericardiotomy. The position of the wound is of some importance but the course of a bullet, or even a knife thrust, is notoriously misleading. There is usually a history of freedom from any symptoms for five to ten minutes after the accident during which time there is profuse hemorrhage from the wound. This is followed quickly by exhaustion and collapse and cessation of external hemorrhage. I believe that Dr. Singleton's suggestion of aspirating the pericardium and removing the blood as a temporary procedure is an excellent one, because the patient may die of tamponade before operation can be performed.

DR. RUDOLPH MATAS, New Orleans, La.: I think this Association is to be congratulated on having these two papers which illustrate so plainly the great progress of cardiac and arterial surgery. Dr. Mason and Dr. Singleton have brought us the very last technique in dealing with this class of wounds.

Dr. Mason's brilliant results in a case of arteriovenous aneurysm of the first and second divisions of the subclavian vessels by excision of the fistulous tract illustrate all the difficulties involved in this class of injuries and especially those that require the control of the subclavian in its intrathoracic division. His management of this case reflects great credit on his operative skill and judgment and I congratulate him on his merited success.

The detailed report of cases of this character is interesting and instructive not only because we all profit by the strategy and tactics exhibited by an able operator in attaining a difficult and often dangerous anatomical and physiological objective, but they are interesting to the historically inclined in contrasting the expectant and conservative attitude of the surgeons of thirty-five years ago towards the arteriovenous aneurysm or fistula in general, and of those of the great arteries in particular, with the aggressive attitude of the surgeons of the present. Up to the beginning of the present century, arteriovenous aneurysms of the great central vessels

* Dr. Mason's article appeared in the May, 1933, issue of THE JOURNAL, p. 451.

were looked upon very justly as a sort of *noli me tangere*. Even as late as the last quarter century the opinion prevailed that arteriovenous aneurysms were relatively benign except for their local or regional effects on the venous circulation and that they were relatively well tolerated and were compatible with a long life, in comparison with the arterial aneurysms which, as a rule, tend to enlarge and rupture. Even now we see that the notion of the comparative benignity of the arteriovenous fistulae prevails in some quarters when it is proposed to cure aortic aneurysms by creating an anastomosis in the jugulocarotid tract in order to reduce the aneurysmal tension with apparent disregard of the grave consequences of such fistulae upon the heart and systemic circulation, especially when the carotid stream is short circuited and poured directly into the upper caval system and right heart.

Thirty years ago, the systemic cardiovascular effects of arteriovenous fistulae were not understood or appreciated. When cardiovascular changes occurred, which ultimately proved fatal by cardiac decompensation and the secondary lesions they cause in the heart and arterial system, they were generally regarded as separate and independent lesions which had no relation to the fistula as cause and effect. In view of the presumed stationary character of the arteriovenous lesions, the principle of non-intervention prevailed and particularly in dealing with fistulae existing between the great vessels of the neck and root of limbs originating in the aorta.

In 1902, when I reported my first operation for an arteriovenous aneurysm of the subclavian vessels, I collected all the cases that had been reported in the literature up to that time. From the first operated case reported by Wattmann, of Vienna, in 1842 (a ligation of the third right division) to 1902, the total number of arteriovenous aneurysms which had been reported amounted to 18 cases, of which 12 had been treated expectantly, or by bloodless methods. The mortality of the 12 unoperated cases was 2, or 22.29 per cent, and of the 6 operated was 2, or 33⅓ per cent. The only importance to be attached to these figures is that they indicate the conservative or expectant attitude of the surgeons of the last century who operated only when forced by necessity, an attitude which was justified by the great mortality that attended all operations in the pre-Listerian period, and by the fact that many of these arteriovenous fistulae are tolerated for years without fatal effects.

Now everything has changed; the frequency of these injuries has enormously increased and especially in military practice, with the introduction of the small hard-jacketed projectile, shell fire and machine guns, which have added enormously to the number of these injuries, but diminished the immediate mortality by creating smaller wounds which permit

of temporary hemostasis, giving an opportunity to perform more curative operations at a later period.

The change that has occurred in the frequency and mortality of the arteriovenous lesions is likewise notable in the treatment and results of the pure arterial aneurysms of the subclavian. The mortality of the ligations of the subclavians for aneurysm up to 1890 was 73 per cent and the permanent cures were only one in 75 cases, or 1.3 per cent. From 1890 to 1903, following the introduction of antisepsis, the mortality fell to 20.8 per cent (Jacobsthal). Up to 1904 it was 22 per cent (Oberst). In the especially difficult and dangerous ligations of the left subclavian, in all 21 cases collected and analyzed by Halsted in 1920, from Kearny Rogers' first ligation (fatal) in 1846, to Halsted's secondary extirpation of a left-sided aneurysm (successful) in 1920, the mortality amounted to 28.5 per cent, all of these patients but two having been operated in the Listerian period.

As an illustration of the results at present obtained in civilian hospital practice, I reported at our Biloxi meeting in 1929, a personal experience of 15 subclavian aneurysms operated upon during twenty-nine years from 1900–1929, without a death.

At present I have the records of 16 subclavian aneurysms, 10 arterial and 6 arteriovenous with permanent recoveries and cures in all. Of the 10 arterial, 6 involved the ligation of the first division of the left subclavian, 2 of which were ligated or banded with aluminum bands in the intrathoracic portion close to the aorta

In my experience from 1884 to 1930, forty-six years, I have had to deal with 36 well-recorded cases in which the subclavian vessels were involved, including 6 unoperated and inoperable arteriovenous aneurysms, which came under my personal care. Of these, 16 were operated aneurysms, or about 41 per cent of the total subclavian cases.

Altogether, the subclavian vessels have furnished me 13.4 per cent of my total experience with the surgical arteries (266 cases).

The experience of the Charity Hospital of New Orleans in regard to the relative incidence of the subclavian injuries is interesting as illustrative of the incidence of subclavian aneurysms in civilian practice. In a total of 1027 aneurysms of all arteries, admitted to the Hospital from 1904–1931, (twenty-seven years), the statistics compiled by my former assistant, Dr. Frank Loria, show that the subclavian group, including arterial and arteriovenous aneurysms, amount to 2.14 per cent of the total aneurysms admitted during the twenty-seven years.

In my Biloxi paper of 1926, I reviewed the reasons for the vast improvement in the results of our operations on the subclavians and especially the arter ovenous fistulae. I wish now to emphasize the changed conditions: Formerly operations for subclavian arteriovenous aneurysms were per-

formed only as a procedure of necessity and non-interference was the rule at a time when the operation would have been safest. Now since we have learned the disastrous effects of the arteriovenous fistulae on the heart and circulation, we operate early in well-established cases and as soon as the collateral circulation has had time to establish itself, in order to avoid the secondary cardiovascular decompensation that ultimately asserts itself with fatal effect, especially when large fistulae are established in the great vessels near the heart.

The fundamental principles that govern the treatment of arteriovenous aneurysms is that the fistula and all intermediary channels of communication between the artery and the vein must be absolutely suppressed by closure of the fistula or the excision of the fistulous tract. This feature of the operation is absolutely essential no matter by which method it is accomplished. Thus far I have been able to accomplish this result by one of four procedures or modifications of these according to the type of aneurysm and the anatomical conditions that are revealed at the operation.

1. In aneurysmal varix (direct arteriovenous fistula, the phlebartery of Broca) which represents from 55 to 60 per cent of the traumatic arteriovenous aneurysms of the extremities. This is the ideal procedure by which the anastomotic segments are detached and the orifice in each vessel is independently closed by suture (lateral angiorrhaphy) thus restoring the normal circulation in each vessel.

2. When this is not practicable, as is more often the case, the fistula is closed by the method of transvenous suture (Matas-Bickham method, 1904). This procedure may be applied as follows: (a) If the vein is dilated and sacculated at the seat of the fistula, open the vein; after completely controlling the artery and vein, above and below the fistula, expose the fistulous orifice and close hermetically by continued transvenous suture, then detach the vein leaving the suture patch on the artery. Close the gap left in the vein by lateral suture. This saves both artery and vein. (b) When there is no excess of vein, close the fistula by transvenous suture after ligating the vein above and below the fistula. Then excise the venous segment between the ligatures, leaving the sutured patch of the vein attached to the artery. This method saves the artery only. (c) Transvenous suture of the fistula as before, but instead of excising the venous segment, obliterate it by overlapping or infolding of the sac walls. This procedure also saves the artery.

3. The quadruple ligature: When the transvenous suture is impracticable, ligate the anastomosing vessels above and below the fistula, and (a) excise the anastomotic segments between the ligatures, or (b) do a quadruple ligature and divide the anastomosing vessels through the fistula. These procedures cure the aneurysm but sacrifice the artery and the vein.

Fortunately, in well-established cases the quadruple ligature is well tolerated though the functional end results are not as perfect as those obtained by the methods which preserve, at least, the artery.

4. Varicose aneurysm (indirect arteriovenous fistula with intermediary or communicating sac). (a) In these cases open the sac and suture every orifice that is visible within it, then close the sac by infolding or overlapping (endo-aneurysmorrhaphy); (b) if the communicating sac has been detached or mobilized by the manipulations, excise the detached parts leaving patches of the sac attached to the sutured orifices in the vessels.

While these procedures may be modified in various ways according to anatomical conditions, the fundamental principles remain the same.

In dealing with arteriovenous aneurysms of the subclavians the transvenous suture with preservation of the artery or both vessels is the method of election. But in many cases, especially in gunshot injuries, in which the anastomotic vessels are buried in a mass of scar tissue, the quadruple ligature often with complete section of the two vessels becomes a method of necessity.

In principle, I believe that in all arteriovenous aneurysms the operator should aim at the restoration of the circulation through its normal channel, saving both artery and vein if practicable, or, at least, preserving the continuity of the main artery.

An operation for an arteriovenous aneurysm of the subclavians is usually a long and tedious operation, which may become quite formidable when undertaken without a very careful and deliberate anatomical dissection. At least four conditions are necessary for success: (1) An absolute prophylactic hemostasis by control of all the vessels leading to and leaving the fistula; (2) a free, wide exposure of the operating field without regard to the sacrifice of the parts of the thoracic skeleton that may be in the way (clavicle, sternum, ribs, cartilages); (3) a thorough local and regional anesthesia which will permit a long, delicate and perfect anatomical exposure. This should be aided by preliminary sedation with morphia and the barbital compounds. These operations require usually from two to five hours. (4) In all arteriovenous cases the anterior route is necessary (Kocher Duval; Sencert-Lexer; Dobrowolskaia), though there are cases in which no sacrifice of bone is necessary. I have resorted to the anterior approach in the purely arterial cases, but I can see advantages in the posterior or dorsal route of Sherill or Arnold Henry.

One fact that we have learned by abundant experience and especially since the World War, is that in well-established arteriovenous aneurysms, the collateral circulation is developed at an earlier stage than in the purely arterial lesions. This is due to the effort of the vascular system to compensate for the loss of tension and blood volume in the artery distal to the

fistula, caused by the short circuiting of the arterial blood into the satellite vein. The shunting of the arterial stream into the vein leads to a relative anemia of the peripheral parts and in response to the demands of the impoverished tissues the collateral vessels on the proximal and distal sides of the fistula dilate and are stimulated to greater functional activity. For this reason, the quadruple ligature or the excision of the fistulous segment is well tolerated and can be performed in all well-advanced cases without serious risk of peripheral necrosis. In my first case of subclavian arteriovenous fistula (1900) I had not been sufficiently impressed with the importance of delaying an operation for the cure of an arteriovenous fistula and I operated on the ninth day after the injury without giving time for the development of the collaterals. Nor, had I then developed the methods that I now systematically employ to determine the efficiency of the collateral circulation. In consequence of ischemia a partial necrosis of the forearm with loss of two fingers left the patient disabled and marred, an otherwise perfect recovery. For this reason, I always test the efficiency of the collaterals and always wait, whenever possible, for a sufficient evidence of a supplementary circulation before undertaking intervention. I deem it imprudent to trust implicitly to the presumption that because an arteriovenous fistula has been long established it is necessarily safe from the risk of peripheral ischemic necrosis and other trophic disorders.

Finally, in contrast with the arteriovenous cases I believe that in pure arterial aneurysms the proximal ligation or occlusion of the main artery as close to the proximal pole of the aneurysm as possible, on the Anel principle, is the primary, and the obligate method. This is the method which I have adopted in all the ten arterial aneurysms of the subclavians which I have operated on, and this simple procedure has sufficed to cure the aneurysm. It is only in the event of relapse that I would attack a subclavian arterial aneurysm directly by open section, intrasaccular suture (endo-aneurysmorrhaphy) or by extirpation of the sac.

Dr. B. C. Willis, Rocky Mount, N. C.: I operated upon a colored man, aged twenty-three years, with femoral aneurysm, who six years before had been shot in the lower part of Scarpa's triangle with a pistol. Three weeks before admission to the hospital he was seized with sudden pain in the upper region of the right thigh. He progressively grew worse, he was admitted to the hospital and after careful study we decided to try to cure the aneurysm as he was completely incapacitated. Before making any incision we controlled his arterial blood supply to the right leg with tourniquet. The sac was dissected free and opened longitudinally and the opening into the artery, that Dr. Matas has so wonderfully described, was seen. The neck of the sac was cleared and exposed so that there was no tissue lying around it next to the artery and the artery was dissected free for at

least 4 or 5 cm. We then examined the lumen of the artery and found a large thrombus extending above and below the opening. This was removed. The medial half of the sac was then cut away flush with the opening in the artery, interrupted silk sutures were then used to close the opening, these being placed so as to include the fibrous and middle coat of the artery. A second running reinforced suture was placed over these. The lateral flap was then trimmed so as to leave a cuff which was then brought over these sutures and secured by silk sutures to the artery so that the flap reinforced the suture line of the opening giving a double breasted effect.

This man was operated upon two years ago. Following this he served as an orderly in the hospital for eighteen months, running up and down stairs without difficulty. There has been no evidence of any recurrence and his limb has a normal circulation.

This treatment of aneurysm may be applicable to the arteriovenous aneurysm where there is a connecting sac, by simple ligation of the neck of the sac proximal to the venous side and the use of part of the flap to close the hole as I did in the femoral artery. I have been unable to find any operation similar to this in the literature I have consulted.

Dr. Robert L. Rhodes, Augusta, Ga.: Discussing Dr. Singleton's paper, in 1924, at the Charleston meeting, I reported 2 cases of heart injuries, and I wish to refer to those. As regards one of the causes of death, exsanguination, why waste that blood? If it is aspirated during the first part of the operation and filtered it may be used in transfusion either into a vien or directly into the ventricle and may be a means of saving life in these operations. I do not think that the danger of infection through a small stab wound or bullet wound is sufficient to necessitate throwing away the blood that may be so valuable.

Dr. W. O. Bullock, Lexington, Ky.: The suture Dr. Matas has brought forward has for its object the occlusion at the lowest point possible, and since we occasionally have to operate on these individuals before the sac is completely organized I have adopted the principle of the intrasaccular ligation. The walls are not sufficiently strong to hold the suture and occasionally I have found that an intrasaccular ligation with obliteration of the remaining sac completes the operation satisfactorily.

Another point in regard to Dr. Singleton's paper, which to me was very interesting as to the force and power of heart compression, is illustrated by a case I operated upon some years ago in which after I started the operation in a case of gunshot wound of the heart the pulse and respiration stopped. I said to my associate, "I have never done one of these things so we will go ahead and do it on the cadaver." There was a wound in the right ventricle and I lifted the heart up in my hand and started to stitch it up. I put in two sutures when the heart began to crawl in my hand. After I had

put in three or four more sutures the heart was functioning normally. I mention this to show that even though the patient is apparently dead we should go ahead and complete the operation. The man recovered and is well today.

Dr. Barney Brooks, Nashville, Tenn.: I had an opportunity of seeing the patient reported by Dr. Mason before closure of the arteriovenous fistula. I have also observed in some of my own cases the rapidity with which marked dilatation of the heart follows the establishment of arteriovenous communication. The effect of the arteriovenous fistula upon the heart is a definite indication for early operation.

I wish to emphasize that the only successful operation for arteriovenous fistula is one in which the complete obliteration of the fistula between the artery and the vein is accomplished.

Dr. Mont R. Reid, Cincinnati, O.: A possible explanation of Doctor Mason's case in which there is a persistence of the bruit: if this bruit is purely arterial it may easily be due to the collateral circulation. I have recently had the experience of operating upon two arteriovenous aneurysms and have observed that there will persist an arterial bruit due to the rushing of the blood through the enormously dilated and tortuous collateral vessels. If one does not recognize that as being entirely different from the to and fro bruit of the arteriovenous aneurysm one is likely to be much disturbed and to think that there still exists an arteriovenous fistula.

Another possible explanation of the persistence of the bruit in his case may be a partial coarctation of the aorta which may have resulted from the ligation of the subclavian artery very close to its origin.

Dr. J. M. Mason (*Closing*): As mentioned in my paper, the accepted attitude in regard to arteriovenous aneurysms is now one of active surgical intervention. No surgical procedure can be considered as firmly established until it has received the approval of internists of authoritative standing, hence I have been much interested in noting the change in attitude of Sir William Osler in regard to these cases. I believe that we may consider that he has spoken for internists in general.

In 1893 we find him referring facetiously to a patient as having escaped from the surgeons; again in 1902 he strongly advises against operation; but in 1915, after observation of results obtained by surgeons in the World War, he expressed himself as being in hearty accord with surgical intervention.

The different methods of dealing with the vessels involved in the fistula or aneurysm have been discussed. Each case presents an individual problem, but the underlying principle is to close the communication between the arterial and venous systems. Seldom will ligation of the artery alone result in permanent cure. However, in the series of cases analyzed in

my paper 3 cases have been treated by proximal arterial ligation alone. These cases are reported by Noon (Abstract No. 1); Matas (Abstract No. 14); and Holman (Abstract No. 8).

In Holman's case deep silk sutures were taken to control arterial hemorrhage and he thinks that it is likely that the subclavian vein was occluded along with the artery. In Noon's case a faint bruit had returned at the end of eight weeks but there was no pulsation. No further observations were reported. The case reported by Dr. Matas was permanently cured. In 1918 I ligated the popliteal artery of a soldier for arteriovenous aneurysm in the calf, but the signs and symptoms recurred after a few weeks.

We may conclude, I believe, that no dependence can be put upon proximal arterial ligation as a method of treatment.

THE TREATMENT OF

FRACTURES OF THE SHAFT OF THE FEMUR

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THE treatment of this injury always has been a more complicated and difficult problem than the treatment of fractures of any other of the long bones.

I shall not deal with the methods that are in vogue and well known to all surgeons, but will confine myself to a description of a plan which I have evolved and employed in 33 cases. My series includes all the various types of fracture that occur in civil practice, namely, simple, compound, comminuted, complicated, transverse, oblique, spiral, gunshot, and infected fractures and non-union as well as vicious union. I have in most instances been able to reduce the period of disability to at least one half the time required by the prevailing methods; while the comfort of the patients has been immeasurably enhanced and the results have closely approached the ideal. My plan does not entirely depend upon the cardinal principles involved in the treatment of fractures, such as splinting, suspension and skeletal traction.

As you have no doubt already surmised, the plan contemplates the use of a device that is made of beef bone which I have dignified by the name of "key." I call it a key because there are certain locking principles involved in its use that make it more than a pin or a peg, but under no circumstances should it be considered a graft as its growth is neither expected nor desired. The factors which endow it with distinctive qualities and exclusive achievement are its relative shape and its obvious purpose together with the detail of its employment. First, it is square, thus presenting four surfaces and four sharp angles that cut into the circumference at four separate points which affords a locking principle and reduces the risk of

splitting to a minimum, although special means are adopted to prevent splitting which will be described later. Experience has taught us that a key should square the diameter of the circular

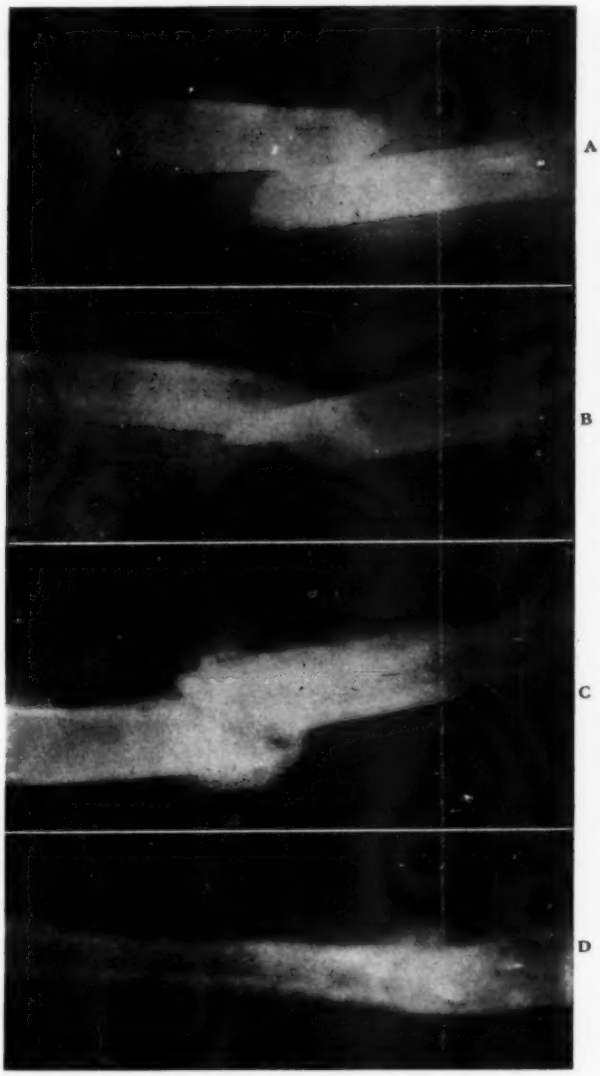

FIG. 1. A and B. Two views of oblique fracture of femur. C and D. Key inserted.

opening in which it is intended to engage. For example, if the diameter of the circle is $\frac{3}{8}$ inch it should engage a key $\frac{3}{8}$ inch square. A little mathematics will teach that a key of such dimension will cut the circumference of the circle $\frac{1}{16}$ inch at

each of its four angles. This phase insures against rotation and contributes security to the position of the key. Second, the key is made to taper, thereby acquiring the qualities and prop-

FIG. 2A. Condition at operation, Aug. 31, 1932.

erties of a wedge which in ordinary mechanics has proved of great importance as a holding factor due to the gradual development of friction during its introduction. The dimensions of the key are varied in conformity to the size of the injured bone.

For an oblique or spiral fracture the procedure is as follows: Calculating the bone to be one inch in diameter, a cone shaped opening ¼ to 3/16 inch in diameter is drilled through the bone transversely. A square key with corresponding dimensions and tapering 1/16 to the inch is then driven through and left protruding ¼ inch on either side. This will be found sufficiently accurate and will hold tight enough to preserve the contact and prevent tripping of the fragments. For driving the key we use a rawhide mallet and a metal set punch which is fitted over the large end of the key so that the strokes of the mallet do not fall upon the key itself, but upon the punch. Care should be taken during the operation to keep both feet exposed, so that comparisons may be made and the drilling should not be begun until the two limbs are in symmetrical posi-

tion. In the event of a transverse fracture it will be found necessary to employ the intramedullary key. In performing this operation, one fragment at a time is fished from the depths of

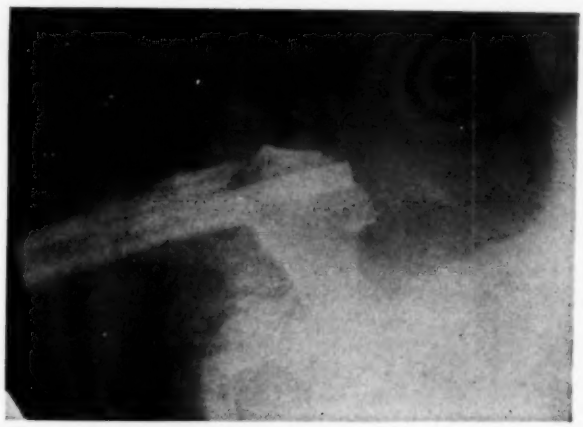

FIG. 2B. Same case. Condition on discharge, Sept., 1932. Key in position. Able to walk on crutches.

the wound with an instrument which we call a clevis forceps. It is the most convenient and useful instrument for that purpose I have ever seen. When a fragment is brought up above the level of the surface, a ribbon retractor is placed beneath the bone and the jagged ends are smoothed with a saw. If there is too much irregularity to get a smooth surface across the entire diameter, as much as possible is obtained without sacrificing more than an inch on each fragment. A gap of 2 inches between the fragments is not a serious obstacle to union. We have found that alignment is more important than approximation. When the ends of the fragments have been satisfactorily smoothed, two Parrot forceps are tightened around the bone, one as near the end as possible and the other an inch or so back. A 4 to 5 inch key with a slow ($\frac{1}{32}$ to the inch) taper is driven into the medullary canal until it becomes firmly situated. The firmness should be tested after loosening the Parrot forceps. Their function is to prevent the bone from splitting while the key is being driven in. If, after loosening the forceps, the key is found not firmly situated, it should be driven deeper until

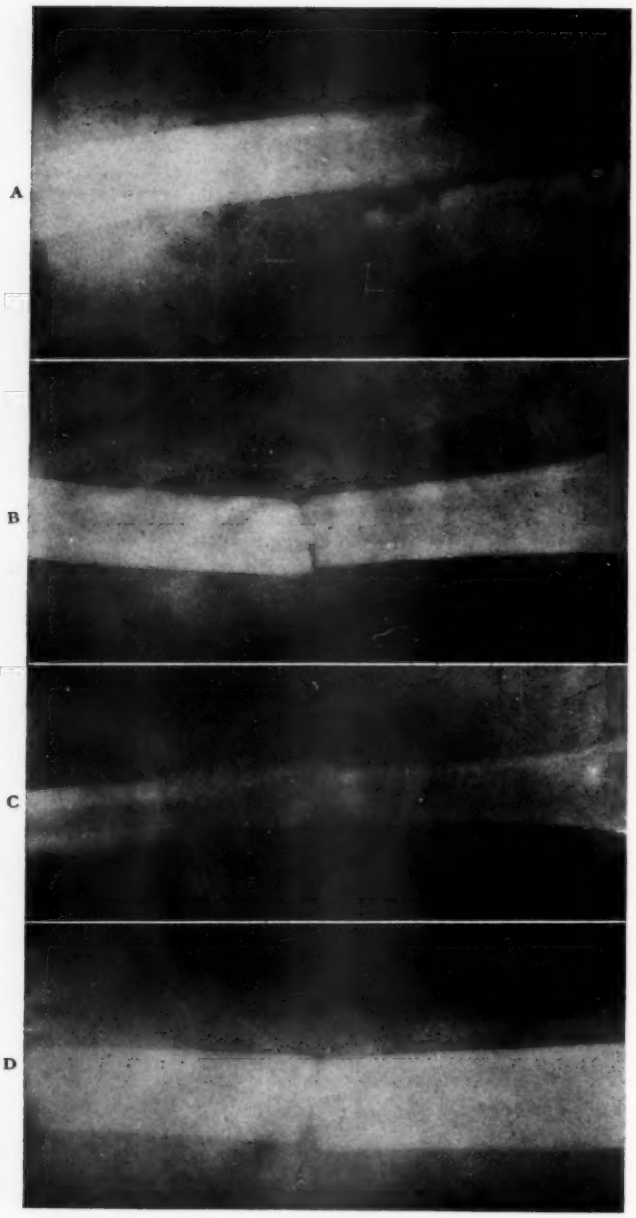

FIG. 3. A and C. Views taken August 28, 1930. B and D. Views taken September 15, 1930.

undoubted security is obtained. Then the opposite fragment is fished out with the clevis forceps and the ends smoothed in the same manner as above. Then by traction and angulation the

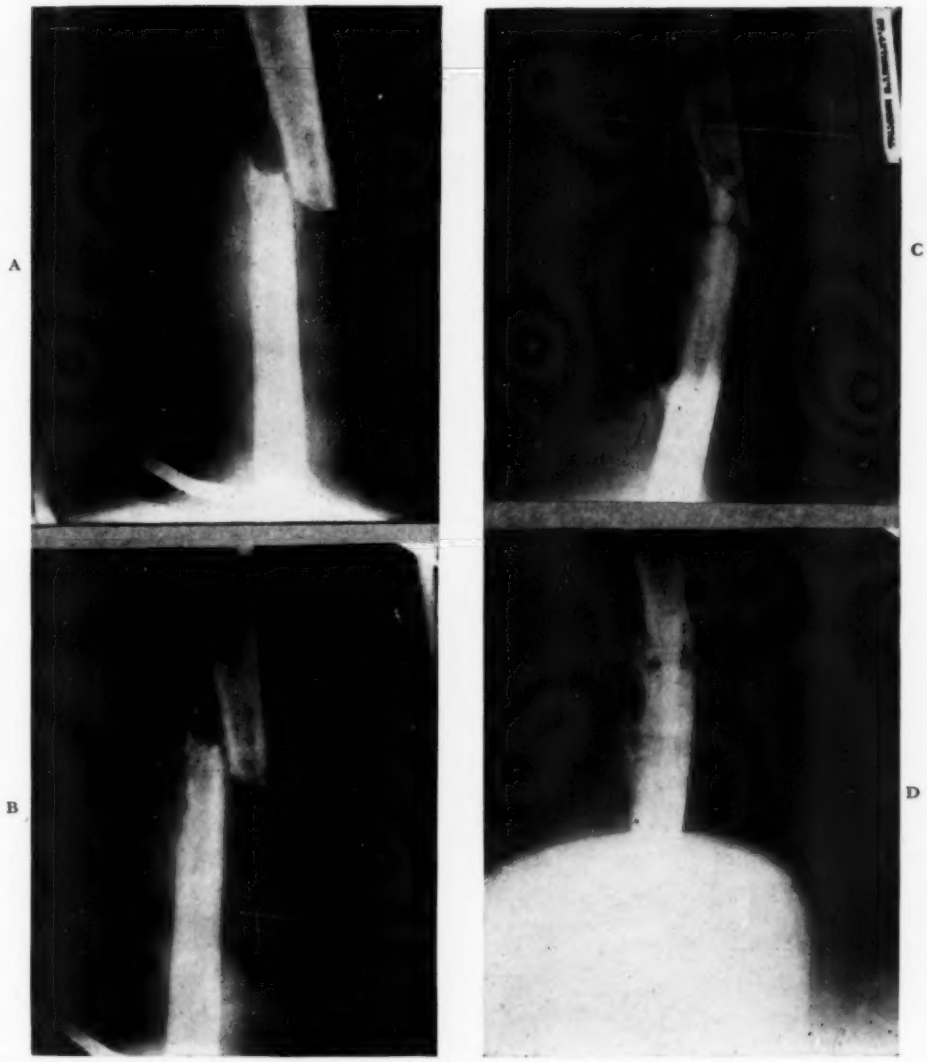

FIG. 4. A. Condition nine weeks after injury; plaster-of-Paris Lane plate; note absence of callus. B. End of bone necrosing; screw holes exuding pus; note absence of callus. C. Three weeks after operation; note callus on concave surface. D. Condition three weeks after operation; able to walk on crutches four weeks after operation.

fragments are separated as far as possible and as much of the projecting key as possible is made to engage in the medullary canal of the other fragment by a buckling process. If the

medullary canal is too small to engage the key it can be reamed out to the proper size. An extremely tight fit is not necessary. The minimum projection that will insure security is one inch.

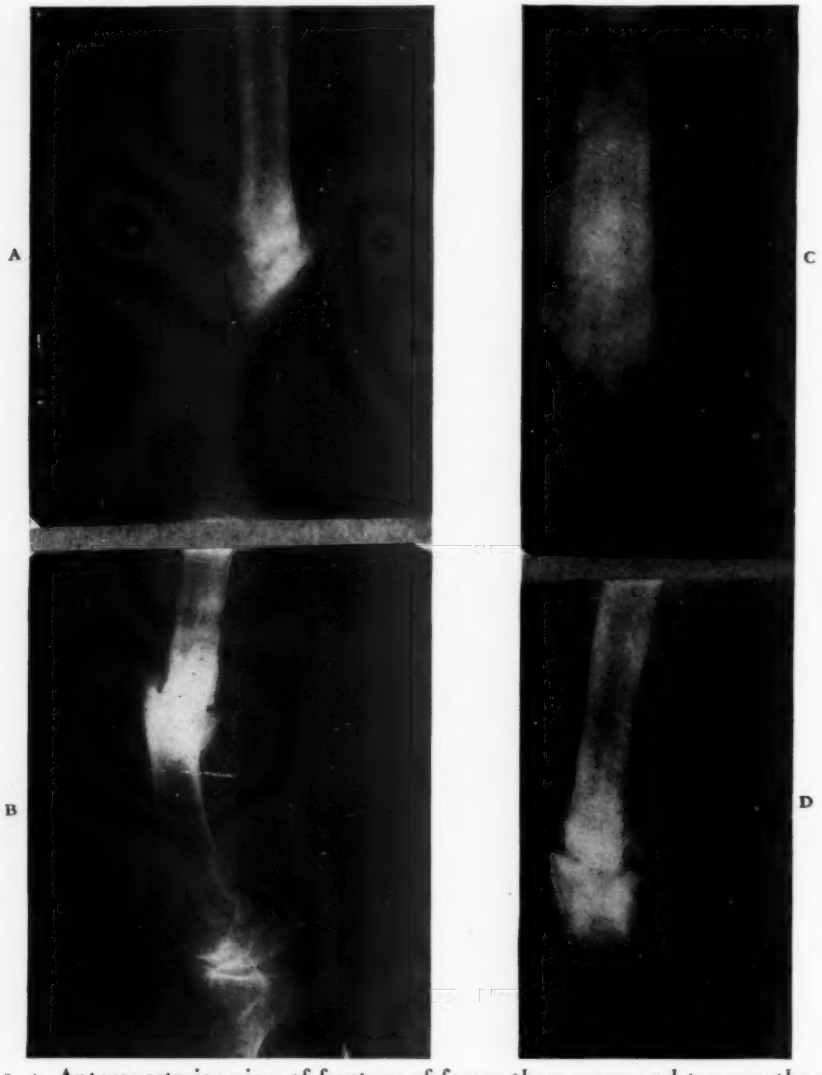

FIG. 5. A. Anteroposterior view of fracture of femur three years and ten months after injury. Non-union after three operations and one year in plaster cast. B. Lateral view. Note false ball and socket joint. C. Four weeks after key operation, anteroposterior view. Note alignment and callus. D. Lateral view four weeks after key operation.

If the projection is too long to engage it may be sawed the proper length. When these steps are accomplished the chief part of the operation is concluded. It is found that keys 2 inches or

under should have a slope of 1/16 to the inch while a key over 2 inches and up to 6 should have a 1/32 inch slope. The longer keys are used in the medullary canal and for fracture of the neck of the femur. It is evident that in a long key a slow taper is adequate, the length supplying the friction surface necessary.

The short keys are made to taper more rapidly than the long ones thus gaining the wedge effect more quickly and thereby compensating for their brevity. Another advantage afforded by the tapering key is that the greatest strain can be directed to the larger and stronger part of the key. It is a well-known mechanical principle that the weakest point of any beam lies equidistant from its two extremities. Therefore, in dealing with intramedullary insertion it is a great mistake to divide the length of the key equally between the two fragments because thereby the heaviest strain is placed at the weakest point of the key. Consequently we leave about one-fourth of the key length exposed to engage the opposite fragment with an anchor-like effect.

These keys are made for me locally and may be obtained in any size desired. We keep them in a jar of 4 per cent carbolic solution and boil them ten minutes immediately before operation. Too much boiling makes them brittle and liable to break.

Naturally the question arises as to their destiny in the bone. Do they become absorbed or remain to give future trouble? In some cases they do absorb in as short a period as one year and I have observed some in vivo as much as six and one-half years after introduction and showing no apparent change. What causes the difference? I have no plausible theory to submit in reply. To my knowledge the ones I have used have never caused subsequent disaster or proved a source of danger.

In adapting the key to the various types of fracture that one meets in practice there are certain rules that may be drawn for guidance. For example: the more rapid taper of 1/16 inch is used in the shorter keys that are employed in a direction transverse to the shaft of the bone, as in oblique and spiral fractures. If the fracture occurs in the region of the lesser trochanter a

hole is drilled longitudinally from above through the shorter fragment in a downward direction. Then the key is driven from above downward through the drilled hole until it engages in the medullary cavity of the fragment below. This should be done after the ends of the fragments have been smoothed as already indicated. Under no circumstances should loose fragments or sharp surfaces be allowed to remain. The wound is then closed by the introduction of deep silkworm gut sutures that go deep enough to touch the bone. These are tied tightly, thereby closing dead spaces and controlling hemorrhage. A row of superficial interrupted silkworm gut sutures is placed one or two between the deep sutures. No drains are ever used except in cases that suppurate. So far we have not had to ligate any blood vessels save in a case that is herein reported. The incision which is always made on the outer aspect of the thigh is then dressed and a board 6 inches wide and ⅜ inch thick and long enough to extend from the gluteal fold beyond the heel is bound to the posterior surface of the thigh with heavy 4 inch muslin bandage interrupted and encircling the thigh at intervals down to the malleolus. The patient then is placed in bed with sand bags along either side of the limb. These may be discarded when they no longer add comfort to the patient. After one week the patient can be turned on the side opposite the fractured leg. In three weeks, if the patient is otherwise strong, he can be allowed in a wheel chair; in four weeks he can be allowed on crutches. We advise the use of crutches for as long as six to eight weeks after the patient is out of bed, though most of the patients have refused to be thus encumbered for a longer period than three or four weeks. Bowing will result if weight-bearing is permitted too soon.

Naturally, the question of infection is the first thought that comes to one's mind when considering this subject and I can say that in my experience it has had very little to do with the bone union, but the fate of the soft tissues has given us the greatest degree of anxiety. We have had infection in 4 cases

which are reported in this paper and I think properly accounted for. In the cases of gunshot fracture in which we have employed this method of treatment, we have obtained union without suppuration. In the case of compound fracture with infection already present we obtained prompt bony union.

PREOPERATIVE SUPPURATION

CASE I. A girl seventeen years old received a fracture of the middle third of the thigh in an automobile accident. She was carried to the hospital and put in a plaster-of-Paris spica, including both legs. After four weeks, the bone being out of position, a Lane's plate was applied and another plaster spica. The site of operation suppurated and the ends of the fragments necrosed and the plate was removed. This work was done elsewhere. Nine weeks after the accident she was brought to me with pus discharging from the screw holes in the bone and an inch of overlapping and necrosis of the fragments. The ends of the fragments were sawed smooth back to healthy bone and a key was inserted after the site of the previous operation had been thoroughly saturated with iodine. The incision was closed without drainage. Suppuration subsided, callus formation took place, and the patient was able to leave the hospital on crutches in four weeks.

POSTOPERATIVE SUPPURATION

CASE II. A boy ten years old sustained an oblique fracture of the middle third of the femur. During the operation a spectator fainted and fell against the field of operation, thereby causing a serious rupture in technique. Extensive suppuration of soft tissues followed but did not seem to interfere materially with the bone union. Several sinuses resulted and persisted for as much as six months. The key came out in about twelve weeks. The boy recovered with complete bone union and no deformity or impairment of function resulted.

CASE III. A boy sixteen years old received a fracture at the junction of middle and lower third of the femur from a motorcycle accident. He was treated five months by means of plaster-of-Paris and ice tongs with no union. During the course of my operation a most terrific hemorrhage occurred. We could not discover its source. By packing we were able to control it sufficiently to introduce the key and buckle the fragments together. The wound was left open with 9 medium gauze sponges packed in. The patient was given venoclysis and blood transfusion through the venoclysis. The patient's condition was very desperate, but after two or

three days he was again taken to the operating room and under anesthetic the packing was removed and the wound closed with silkworm gut sutures. Suppuration followed. Drainage was instituted and a long course of treatment ensued which finally resulted in complete recovery with no shortening and no impairment of function except limitation of movement of the knee joint.

CASE IV. A man, thirty-six years old, a legion parader, attempted to traverse the route on stilts 10 feet from the ground. As he neared the end of his journey he lost his balance and fell, fracturing his thigh in the upper third. He was operated on at the City Hospital. Three days later, over the objections and advice of the staff, he was transported a hundred miles over rough road to his home. He had profuse suppuration according to the correspondence I had with his physician. I was unable to obtain a complete subsequent history, but a year later he walked into my office with scarcely an inch of shortening and perfect union.

CASE V. A subject of vertebral tuberculosis and exaggerated dorsal curvature, a man, thirty years old, had a fracture at the junction of the upper and middle thirds of the thigh as a result of an automobile wreck. This patient was extremely frail and had a fibroid phthisis. About one week after operation suppuration ensued while he was in the hospital, which was four weeks in all. A year later, he wrote me that he had been reoperated upon and had secured union with about 2 inches of shortening.

ACCIDENTS

CASE VI. A man with fracture of the middle third of the femur was operated on at the City Hospital. This patient proved to be insane and uncontrollable. The night after the operation he succeeded in dislocating the short end of the key by breaking a section from the cortex of the fragment in which it was embedded. This was remedied by replacement under anesthetic without reopening the wound. Plaster spica was employed and the patient recovered with good results.

CASE VII. A boy seventeen years old had non-union in the middle third of the femur. The key was not driven in with sufficient firmness and when the fragments were buckled instead of the projecting key engaging in the opposite fragment it was pushed back up into the medullary canal of the fragment in which it had been driven. After several days this accident was revealed by an *x*-ray. The incision was reopened and a larger key inserted. The fragments were buckled together in the proper manner and the patient made a prompt recovery. No infection occurred.

CASE VIII. A boy, aged sixteen, had a fracture of the middle third of the femur. Two years later he suffered a fracture at the original site

while playing football. The callus was fractured but the bone key still held. I did not see the case at this time but was informed that the leg was opened and the key removed though still intact.

There was one death in the hospital two weeks after the operation caused by cancer of the uterus which was present at the time of injury.

SUMMARY

I am presenting this subject because I never have seen published any report that embodied the same principles or the same technique or the same results that I have obtained. The method is to be recommended because it shortens the period of confinement and disability at least 50 per cent. It relieves the patients of the heavy burdens with which they are encumbered when the external methods of immobilization are relied upon. Their position while in bed can be altered at will and proper hygiene is much more easily and safely accomplished. The local circulation and nutrition in the leg is so little interfered with that upon recovery the patient can almost at once resume the muscular control of his injured limb. There need be no fear of shortening by overlapping. The danger of infection can be dismissed as a serious obstacle because the commonly accepted standards of modern asepsis render infection a remote possibility and should it occur the process of bony union is not gravely interfered with. The non-touch technique is not considered essential and was not used in our work.

An analysis of my cases shows a total of 33 in which there was no mortality attributable to the operation. There were 4 cases of suppuration, all of which are explained, and all finally obtained complete union. There was one compound fracture which had existed three months before operation in which prompt union occurred and a useful leg was obtained. There were three gunshot fractures, all of which united promptly. Two cases previously had been operated upon. Other methods had been tried and failed in 15 cases of non-union. The period

of non-union ranged from four weeks to three years and ten months. There were 3 cases of accidental complications, one due to faulty technique, one to an uncontrollable patient and one to the traumatic hazard of football. A case of only four weeks' duration was classed as non-union because at the end of that time there was overlapping and suppurative necrosis of the fragments and no evidence of callus formation.

SURGICAL FUSION OF TUBERCULOUS HIPS IN CHILDREN

O. L. MILLER, M.D., F.A.C.S.

CHARLOTTE, N. C.

JUDGING from published discussions, pro and con, on the management of tuberculosis of the hip in children, surgical fusion appears to continue a somewhat unsettled question. Those of the persuasion that the hip should not be operated on at all are probably more in error than those who insist that every tuberculous hip should have operative fusion. Leaning toward the school of thought of the latter, a brief report of experience with tuberculous hips in the service of the North Carolina Orthopedic Hospital is submitted.

Only for the past eight or ten years has surgical fusion of the tuberculous hip been practiced, and even for fewer years in some centers. This treatment was thoroughly tried out at the New York Orthopedic Hospital and Dispensary prior to 1926 and in that year Dr. Russell Hibbs, reporting 20 cases operated upon, began crusading for universal adoption of the method. No one who saw Hibbs' results or heard his reasoning without bias could help being impressed with the fact that an advance was being made in the management of tuberculous hips. Since that time in practically every American orthopedic center some hips have been fused in the treatment of bone and joint tuberculosis.

We did our first hip fusion operations in 1927. Naturally, we had to pass through a period of timidity in reconciling this procedure to old surgical training which taught us not to do plastic surgery, nor expect a clean operative result in a known septic field. There was also justifiable concern over adding the shock of such a selective operation to an already ailing child. However, by careful preparation of these children for surgery and even more careful approach to the hip joint

itself at operation, a comparatively safe technique for accomplishing fusion was developed. While some have advocated doing this operation in the very early stage of acute tuberculo-

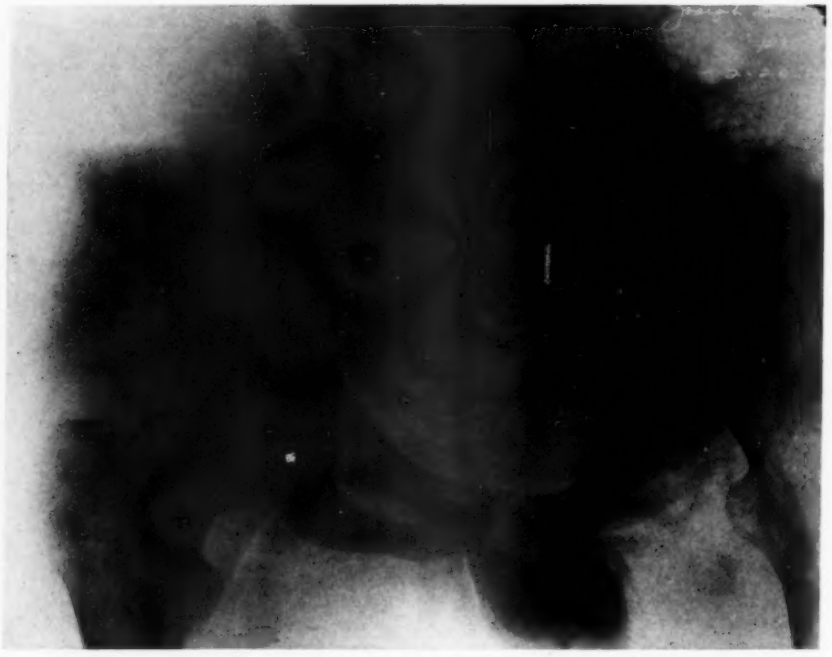

FIG. 1. Case 1. Tuberculosis, right hip. Appearance prior to fusion operation.

sis of the hip, it has been our practice to treat the tuberculosis as a general disease for a while, protecting the diseased joint, and getting the child in the best possible physical shape in keeping with his infection. Since the operation is one of election, there is no real reason for hastily adding a certain amount of known shock to a patient already using the limit of his resistance in combating disease.

It is our feeling that surgery is not indicated in a tuberculous hip when the patient has a moderately high temperature, evidencing acute, active disease. Under a regime of rest in bed and reasonable protection of a diseased joint, the temperature will assume a lower level or become normal. This interval of time may be a few weeks or a few months. In this series of cases the patients were often not presented for treatment until much

of this invasion period had intervened. We have not practiced fusing hips until the temperature curve attained a rather fixed level, either normal or only slightly above.

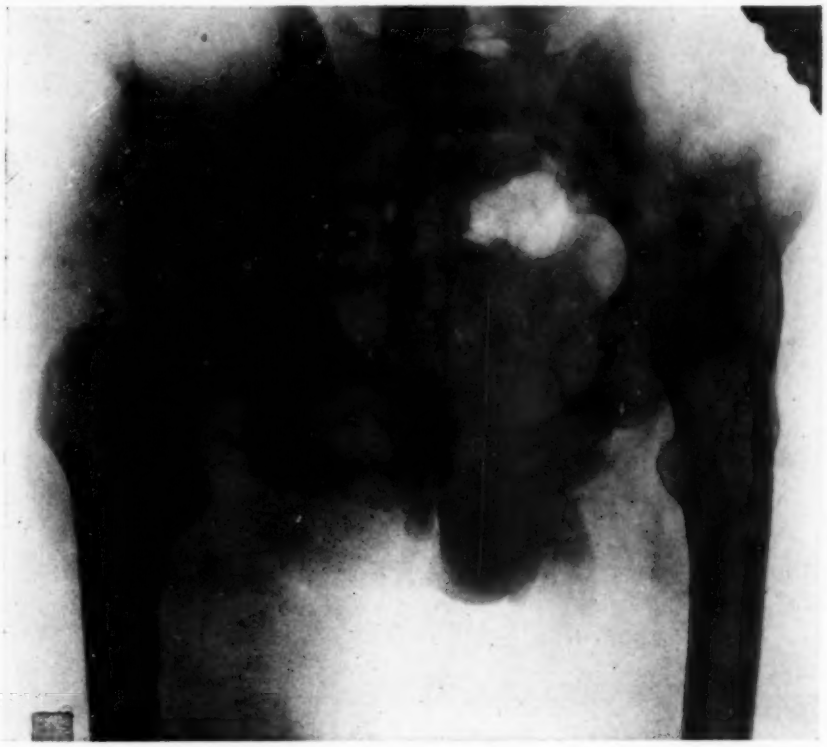

FIG. 2. Case 1. Two years after operation.

As general preparation for this surgery it is also well for the patient to have a period of supervised heliotherapy until the skin shows its advantageous effect. An accumulation of subcutaneous fat should be present, evidencing the child's capacity to combat tuberculous infection. When some such physical picture is present, a patient may be considered safe for surgery. During the first few months following operation and spica fixation of the diseased joint, general institutional treatment of tuberculosis must be continued with vigilance.

Biopsy has not been considered a routine necessity and we are inclined to do fewer rather than more of these procedures, particularly if it is necessary, as has been the case here, to

close the wound and wait for the pathological report. Of course, in the comparatively early cases or where the clinical picture in the hip is uncertain, biopsy should be done and its

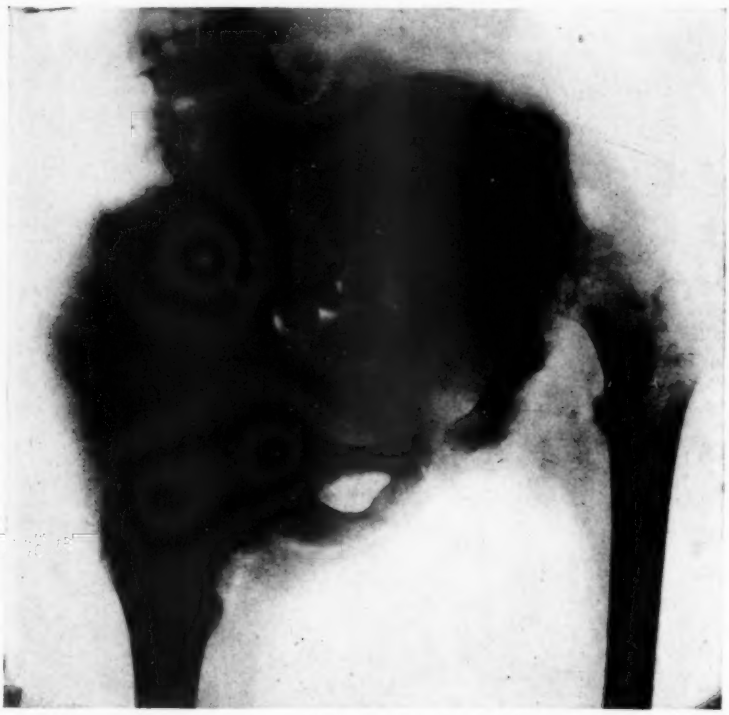

FIG. 3. Case 11. Tuberculosis, right hip, with deformity.

disadvantages, such as we have experienced, should not be considered. In a diseased hip of some duration, with a suggestive history of tuberculosis, with positive tuberculin reaction, with a roentgenological picture ruling out most of the other known hip joint affections, and with a child presenting general clinical characteristics of this disease, one should make a fairly definite diagnosis of tuberculosis. Then, if operation is decided upon, the surgeon will usually have the benefit of seeing the lesion in the hip joint, with its tuberculous characteristics. It should be rare, then, for a non-tuberculous hip to be fused in the absence of routine biopsy practice.

If biopsy is practiced and an interval occurs before the fusion operation, certain complications and disadvantages may

be expected. This of course does not apply to clinics prepared to do frozen section work at the operating room. When a biopsy is done and the wound closed for an interval, the child

FIG. 4. Case 11. Appearance of hip eighteen months after fusion operation.

has had an operation, in extent only slightly short of a complete fusion procedure. Sinuses are inclined to develop where they did not already exist and mixed infection may follow. This makes the patient a poorer subject for the hip fusion and the operation more formidable in every way. When a fusion is done some time after biopsy, scar tissue will be present, the lines of cleavage disturbed, the approach to the joint more bloody, and the chances of shock greater.

In our first hip fusions an attempt was made to follow closely the Hibbs technique of using a portion of the trochanter as a graft between the ilium and the femur. In later operations the grafts have been obtained from the exposed crest

and side of the ilium. Generally speaking, the success of the operation is dependent upon a massive graft across the joint space and firm engagement of the transplant into healthy bone

FIG. 5. Case III. Tuberculosis, right hip.

in the ilium above and the femur below. Where the bone for graft is obtained need be no issue, but getting plenty of it is essential. The technique of Wilson, or some slight modification of it, has now become our practice and appears to accomplish the firmest fusion in the shortest time

The hip joint is approached through a Smith-Peterson incision and the operation is comparatively bloodless. No effort has been made to do extra-articular fusions as we believe this is a rare experience and somewhat of a misnomer in reports on such operations. A para-articular fusion is attempted. The joint is opened down upon freely and the outer aspect of the neck and head of femur and the acetabulum well exposed and denuded of soft tissues. If the cartilage appears undermined by disease it is removed. A bed is prepared for the graft by scarifying the upper, outer aspect of the neck of the femur

(where the neck remains), driving the chisel into the base of the trochanter below and the roof of the acetabulum above in a line suitable to take the graft securely. One massive piece of

FIG. 6. Case III. Fourteen months after first fusion operation, showing line of absorption through center of graft. This defect was later closed with graft from tibia.

cancellous bone should be used as a graft and an ample one may be obtained from the crest of the ilium. This is firmly driven into the prepared bed, passing from rather deep in the ilium along the femoral neck and into the substance of the shaft. In addition to the one massive graft, many smaller slivers of bone should be taken from the side of the ilium and pressed into any dead space along the graft bed, particularly across the old joint line and in the joint space. The wound is tightly closed even if free pus has been encountered in the operation, and the hip dressed in a long snug-fitting plaster-of-Paris spica.

Some observers believe that an apparently well-fused hip will always flex a few degrees within a year or two following removal of spica protection. Granting that this may happen

it is safer to dress the hip in a position of very little or no flexion at the time of operation. If flexion of a few degrees occurs later, instead of being harmful it will only contribute to the

FIG. 7. Case IV. Extensive tuberculous involvement of left hip.

angle of election for ankylosed hips. If no flexion occurs one still has a safe position for weight-bearing, and satisfactory compensation is afforded by the spine when sitting.

Following operation, occasionally, the hip will drain, establishing a sinus through the incision line or through some old dormant tract. In such an event the spica is windowed for dressing and postoperative care continued as if no such complication had occurred. Already existing sinuses are not contraindications to operation. Many wounds close per primam even when free pus has been encountered about the hip. If there are no contraindications the general rule is to allow the patient out of bed for graduated weight-bearing in a spica three or

four months after operation. This measure will stimulate bone production and hasten ankylosis. An *x*-ray check at intervals will show the progress of the fusion or absorption of the graft.

FIG. 8. Case IV. Four years after fusion operation.

If the fusion has been primarily successful the hip joint is protected by a short or walking spica for twelve to eighteen months. When the hip appears to be fused clinically, when a strong bone graft is demonstrated by *x*-ray, and disease appears inactive, spica protection is discontinued and free weight-bearing allowed.

In spite of every precaution some hips will fail to fuse on the first effort. This is particularly true in cases operated upon early, where the disease is acutely active and the lytic agent in the exudate most destructive. The only precaution we have known to take has been to delay surgery until the stage of acute invasion of the disease has passed, then do the operation using large, well-placed grafts as already described. When a hip fails to fuse the graft has usually been partially absorbed by active exudate from the old lesion.

There is no point of selectivity for this destruction. The defect may occur at either end or across the middle or grossest portion of the graft. When fusion is not obtained by the first

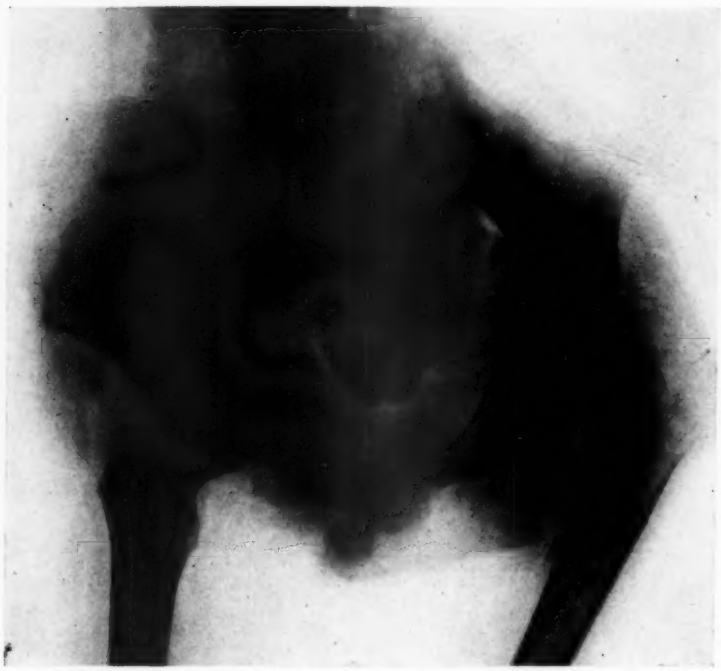

FIG. 9. Case VI. Tuberculosis, right hip, with deformity.

operation it is well to wait a few months and repeat the procedure, using a piece of tibia for the next graft. At a second operation much bone production will be found to have occurred about the joint and this lends itself to a successful conclusion. In all of our cases requiring a second operation fusion has occurred promptly afterwards.

The observations in this paper are drawn from an experience with 45 cases. Tabulated details show the operation to have been done on 27 males and 18 females. The average age of the patients at the time of operation was seven years, the youngest three years. Six cases required refusion due to absorption of the graft. One death occurred the day of operation, presumably from pulmonary embolus. Meningitis was not a complication in a single case.

Opening a tuberculous hip seems to attenuate the lesion, much like opening the abdomen in tuberculous peritonitis. The blood supply about the hip is increased and local resistance

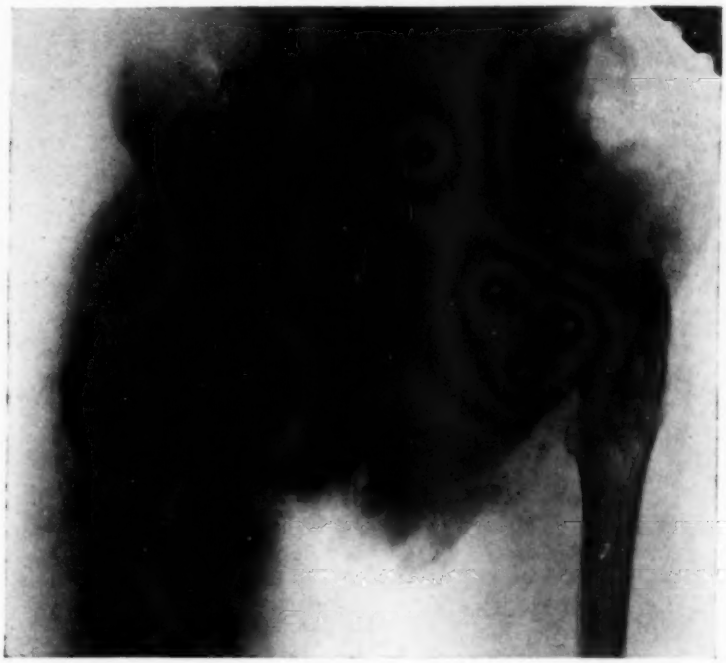

FIG. 10. Case VI. Appearance eighteen months after operation.

evidently stimulated. Two hips biopsied and found to be tuberculous fused spontaneously when operation had to be postponed because of other complications. This is an observation and not proposed as a method of treatment. We have seen no cases of unopened hip joints, apparently definitely tuberculous, fuse spontaneously. Quite a number have been observed for a long period with this in mind. In one case particularly, in this series, in which the hip was believed for a time to have healed with motion, the patient eventually returned with active hip joint disease and now, following operation, has a well-fused hip without pain or apparent active disease.

Operation has been carried out in various stages of advancement of the disease and destruction in the hip joint. Where there is great destruction of the joint elements and extensive

bone and soft tissue infiltration, the hazard of obtaining a strong bone graft is increased.

Tuberculosis of the hip was treated at the North Carolina

FIG. 11. Case VIII. Left hip, proved tuberculous by biopsy. Very little bone destruction.

Orthopedic Hospital for a number of years following what is known as the conservative or non-operative method. The end results were indefinite and unsatisfactory. Knowing when a child could safely be dismissed was a difficult problem and re-admission with advancing disease and other complications was a common experience.

For the past several years we have practiced surgical fusion of tuberculous hips, where there were no contraindications, and carried on general institutional treatment and observation somewhat as before. Other than one surgical death in a negro boy there have been no apparent untoward results so far from

the operation as practiced. Children have been dismissed from the hospital earlier and with more certainty of their future well-being. They have been observed over quite a period of time, have

FIG. 12. Case VIII. Appearance after fusion.

appeared to be clinically well and thrived without interruption or the necessity of constant re-admission to the hospital.

Our experience thus far, therefore, leads us to feel that surgical fusion of the hip has proved a valuable adjunct to the clinical and economic management of tuberculosis.

CASE REPORTS

CASE I. J. G., male, aged fourteen, was admitted to the hospital in July, 1927. He had been complaining of pain in right hip for three years. His father died of tuberculosis. The diseased hip was in 35 degrees flexion and considerable adduction. The joint was so rigid that on first inspection it seemed to be ankylosed. Later, this proved not to be true. After a period of rest in bed with traction on the lame leg, considerable deformity per-

sisted. A subtrochanteric osteotomy was done, the residual deformity corrected and a strong spica applied. It was hoped that further fusion would take place in the infected hip. The boy was under observation of the clinic for almost two years.

After carrying out conservative measures on what appeared to be a benign and probably self-healing hip it became evident that time and other things were being wasted on such a program. The hip was fused in June, 1929, the trochanter being used as a graft, with some additional bone from the side of the ilium to reinforce it. Free pus and much caseous, tuberculous material were encountered in the hip joint. The wound closed per primam. Protected weight-bearing was allowed at the end of three and one-half months. The hip was thoroughly fused in eleven months when artificial protection was discontinued. The boy has been well since, over two and one-half years, and judging from the clinical and *x*-ray appearance he is permanently well of tuberculosis in the hip joint.

CASE II. A. C., female, aged eleven years, was admitted to the hospital in March, 1927, with a history of pain and deformity in the right hip, of about three years' duration. There was no history of tuberculosis in the family. A working diagnosis of tuberculosis of the hip joint was made from the history of the case, from the *x*-ray appearance of the joint, and a positive tuberculin reaction.

The patient spent three and one-half months in the hospital with traction on the lame leg before the fusion operation. The deformity in the hip was corrected and the child appeared to be surgically fit for operation.

The right hip was fused in July, 1928. Much pus was encountered in the wound. A good portion of the joint cartilage was free and could be lifted out with forceps. The lesion was characteristic of tuberculosis. The trochanter was used as a graft in this case. Some sinus formation occurred in the incision line and persisted for several months. Weight-bearing in a spica was allowed at three and one-half months. All protection was discontinued one and one-half years after operation. The child has been free from symptoms since and is in good general physical condition.

CASE III. J. F. C., male, was four years of age, when first seen at the clinic in June, 1924. Pain, lameness and deformity had existed in the right hip for a year previous. On admission to the hospital the hip was flexed 90 degrees and weight-bearing was hardly being attempted. No family history of tuberculosis was obtained. From the clinical appearance of the child, *x*-ray appearance of the joint and a positive von Pirquet reaction, a diagnosis of tuberculous arthritis was made. The deformity at the hip was gradually corrected by traction and a protecting spica applied.

This patient was in and out of the hospital for four years. When he was not resting in bed at the hospital with the leg in traction he was at home

in a spica cast. The disease was gradually and steadily advancing, destroying the head of the femur and the acetabulum.

In September, 1928 the hip was fused. A graft was taken from the side of the ilium. Considerable breaking-down of the wound occurred after operation but cleared up in a few months. Weight-bearing was allowed in a protecting spica seven months after operation.

X-ray check on the progress of the fusion at eight months showed an area of destruction through the center of the graft. Protection was continued and re-fusion done sixteen months later. This time a piece of bone was taken from the tibia to bridge the defect in the first graft. The disease here seemed more than ordinarily active in destroying the grafts but the joint fused following the second operation. Artificial protection of the hip was discontinued fifteen months later when it was evident from *x*-ray and clinical examination that fusion had really occurred. A check-up from time to time since in the clinic has shown satisfactory progress both in the well-being of the hip locally and the boy generally.

Case iv. L. P., male, aged five years when admitted to the hospital, had a history of disease of the left hip for over three years. Family contact with tuberculosis was known. An *x*-ray showed definite destruction and abscess formation in the hip. The joint was flexed 75 degrees. There were several discharging sinuses in the upper portion of the left thigh and a positive von Pirquet reaction was obtained.

This boy had already spent over two years in other hospitals. He was an abject-looking creature with his increasing deformity, active disease and large, multiple draining sinuses. After six months' rest in bed, with heliotherapy and general hospital care, and considerable correction of the deformity by traction on the leg, surgical fusion of the hip was undertaken.

Operation was done in August, 1928. There was still some drainage from sinuses about the hip. A graft was taken from the side of the ilium. There was some sinus formation in the incision following operation but *x*-ray check of the hip at intervals showed the graft surviving. Weight-bearing in a spica was allowed at ten months and protection was continued for two years. The patient has been seen in the clinic at intervals for two years since all artificial protection was removed. The hip remains solidly fused and all sinuses are closed. The child appears to be thriving in every way. The lame leg is one inch shorter than the sound one. An *x*-ray check of the left hip shows firm bony ankylosis and no apparent active disease.

Case v. L. L., male, aged three years when first admitted to the hospital, gave a history of pain in the left hip of two months' duration. The mother was known to have tuberculosis. This child spent about four years in the hospital having treatment for a double lesion, the left hip and twelfth dorsal vertebra. The spine fused spontaneously but disease

in the hip continued active with sharp destruction of the femoral head and acetabulum.

The diseased hip was surgically fused in January, 1930, when the child was seven years of age. Bone for grafts was taken from both the ilium and the trochanter. The wound healed per primam. Weight-bearing was allowed in a spica twelve weeks after operation. Further convalescence was uneventful. All protection was removed one and one-half years after the fusion operation. The child has been observed in the clinic from time to time, has no discomfort in the hip and seems to be thriving.

CASE VI. M. H., male, aged seven years when admitted to the hospital, had a history of pain in the right hip for two years, with gradually developing deformity. The mother died of tuberculosis when the child was five years of age. The von Pirquet test was positive. Both the clinical appearance of the child and the *x*-ray appearance of the hip denoted tuberculosis.

Under general institutional care the deformity of the hip was corrected but the child remained sick and septic. Abscess formation occurred and drainage was required at two points about the hip.

Following a year's rest in bed with heliotherapy, forced feeding, and protection of the diseased joint, conditions improved. The sinuses closed and decision was made to fuse the hip. Operation was carried out in April, 1928 when the child was eight years old. Abundant caseation and destruction was observed in the hip joint. No ankylosis was apparent. Bone for the graft was taken from the crest and side of the ilium.

Shortly after operation a large sinus developed through the wound and drained freely for a time. Convalescence was rather stormy at first due to sepsis about the hip, and tedious altogether for about eight months. Eventually the draining sinuses closed and nine months after operation protected weight-bearing was allowed. An *x*-ray check of the hip showed fusion taking place and the bone graft surviving in spite of the long postoperative drainage. Protection was continued for twenty months when the hip was found to be fused.

This patient has been observed in the clinic from time to time for three years. The hip has remained fused and painless in a position of 15 degrees flexion. The child is well and thriving.

CASE VII. V. T., female, aged five when treatment was instituted, had a history of complaint in the right hip for almost a year. The father died of tuberculosis.

On admission to the hospital the hip was acutely flexed, adducted and painful. The child was quite ill and exhausted from combating disease, and from the fatigue of protecting the painful joint. A diagnosis of tuberculosis

of the hip was made from the history of the case, from the *x*-ray and clinical appearance and a positive von Pirquet reaction.

This child remained in the hospital about ten months before operation. No sinus formation occurred about the hip. She thrived in a general way under institutional management. The hip was fused in February, 1928, bone from the side of the ilium being used as the graft. The wound healed without drainage.

Protected weight-bearing was allowed three months after operation. All protection was removed at fifteen months when the hip was solidly fused in 15 degrees flexion. This patient has been followed in the clinic for over two years and is now in excellent general health.

CASE VIII. R. F., male, aged four years when first presented for examination, had complained of mild discomfort in the left hip and knee for several months. There was no family history of tuberculosis. The condition in this hip was thought to be a transient infectious epiphysitis. The appearance of the hip from the *x*-ray was not suggestive of tuberculous arthritis and the tuberculin test was negative.

After a few months in the hospital the child appeared so improved that he was allowed to go home without protection. He was observed from time to time in the out-patient clinic. Within a few months he began guarding the hip quite noticeably, and though no bone destruction was evident in the *x*-ray, he was readmitted to the hospital and biopsy performed on the left hip in June, 1931. A diagnosis of tuberculosis was made from the tissue removed.

The hip was fused in August, 1931, bone for the graft being taken from the side of the ilium. An *x*-ray check of the progress of the graft one year after operation showed strong fusion and artificial protection was discontinued at that time. This child is still under observation of the out-patient clinic.

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DISCUSSION

DR. WILLIS C. CAMPBELL, Memphis, Tenn.: I would like to emphasize one point and that is that these operations are adjuncts to the treatment of tuberculosis of the hip. They should not be looked upon as curative. We must realize that tuberculosis is a general disease and must be so treated, with heliotherapy and all other means, before operative interference and afterward until union is absolutely solid.

Good results can be obtained and have been obtained by conservative measures in the treatment of tuberculous joints, but the fusion operation increases the percentage of excellent results very materially. The tissue has to go through a process of evolution for complete healing and fusion of the joint. This often requires many months, and one cannot expect to secure solid union in a short space of time.

We must consider the question of growth also. As the child advances in age adduction deformity may occur, and does in many cases. This is not a disadvantage, for if you have suppressed the local disease by this method you can easily correct the adduction deformity later. The improvement we see is not alone induced by the fixation but also by the implantation of new bone with efficient osteogenesis in the area. The placing of bone grafts in tuberculous regions has been employed for the purpose of stimulating osteogenesis. Good results have been reported.

The most favorable time for operation is in the early stage before extensive destruction, and in the late or dormant stage after regeneration. However, fusion is by no means contraindicated when there is active destructive change, but at this time is obviously less favorable, as there is more chance of secondary infection, and also the quality of the surrounding bone and the resistance of the patient are often more impaired.

Dr. William L. Sneed, New York, N. Y.: I wish to congratulate Dr. Miller upon operating and fusing in 45 cases of tuberculosis of the hip with only one death. In our experience we have been more unfortunate. Even in the cases in which we were as careful as possible there has been miliary tuberculosis and meningitis. We have had deaths from miliary tuberculosis and meningitis. I do not remember having deaths connected with the fusion operation.

We should remember what Dr. Virgil P. Gibney accomplished in tuberculosis of the hip by conservative measures. His idea and also that of Dr. W. T. Bull was not to operate on tuberculous cases unless they had to, and when indicated to do as radical an operation as necessary. The fusion operation is without doubt an addition to bone and joint surgery and it is indicated in certain cases, but we must always remember that any tuberculous case is a poor operative risk and we have to be extremely careful in our summing up of the case as to whether there might not be a lighting up of other foci, such as miliary tuberculosis and meningitis. The presence of an abscess does not make any difference as a rule unless there is mixed infection.

Dr. William A. Boyd, Columbia, S. C.: Within the last few years the question of fusion of the hip in tuberculosis of the hip has come forcibly to the front. We all realize that it is an exceedingly difficult question to determine when a tuberculous hip is cured. All of us have seen recurrences in hips that from clinical and roentgenological evidences we had considered

cured. Fusion of the hip in tuberculosis, in my opinion, is a decided improvement in the treatment of these cases. Certainly in the clinic cases, where the long hospitalization and the frequent recurrences are not only very trying upon the physical well-being and the morale of the patients, with the ever-present danger of dissemination of the disease to other organs of the body, but also a serious burden on the family budget and meager finances, fusion of the hip, I feel, is the best method of treatment. In my section of the country, where we have no endowed hospitals, the handling of these cases must be considered from the economical side as well as the surgical.

I have been very gratified with the results in those hips I have fused in the last three years, not a large series, but enough to convince me of the value of a fusion operation. Recently I was much pleased to have a patient, whose hip I had fused, come in to the clinic; she had gained in weight, had been free of pain and much to my surprise stated that she had been working, because of the hard times she had been forced to go into the fields and pick cotton to help care for the family. This patient had not been dismissed from the clinic, but was under restricted activities, and yet, notwithstanding her work in the fields, had no pain or discomfort.

The report by Dr. Miller of his series of cases, the largest number reported so far by any one surgeon, with their excellent results, is quite convincing of the value of hip fusion in these cases.

Dr. W. Barnett Owen, Louisville, Ky.: Fusion of the hip joint is a step forward in the treatment of the disease. It saves time and much deformity also and the disease is arrested much earlier than in those cases treated conservatively. We do not use the word "cured" in tuberculosis in any case, but we feel that probably 75 per cent of the patients that have had hips properly fused and thoroughly treated, and in which there have been no complications, are saved a lot of deformity and time spent in hospitalization. It is very noticeable in our institutions since we began fusing tuberculous joints in various parts of the body that the patients who would formerly lie there for years are not in evidence. We have very few cases of tuberculosis of the hip and spine compared with the old days. It is interesting to notice the different attitude the medical profession throughout the country has adopted on this subject. I recall several years ago in Dr. Hibbs' hospital he was enthusiastic, and he deserves credit for insisting on fusion of these joints. He showed us a number of cases, several of them tuberculous hips, and cases treated for years under the most favorable conditions. He had a hospital in New York City and a convalescent home in the country. It was interesting to watch these patients and to watch the *x*-ray study, and to note the great advance in the disease in those treated conservatively. We went to a joint meeting of the American and the British Orthopedic Associations and it was interesting to note the

difference of opinion in England. They treated the cases conservatively, with few exceptions. At Rollier's place in Switzerland he treated all cases conservatively but I am not so sure what happens to those patients when they go home.

I am convinced that fusion is the method of choice and I would do the operation as soon as I was certain about the diagnosis. We do not do biopsies, as Hibbs did. We feel that this is not justifiable in all cases but wait until we are certain we are dealing with a clinical tuberculous hip. I have in mind many cases of much the same type that have extended over several years. One patient, a doctor's son, began treatment when he was four years old but now has 5 inches of shortening, although he was given advantage of the best known conservative treatment. I think if we had had the judgment to accept an ankylosed hip the disease could have been arrested and the length of the limb preserved.

Dr. O. L. Miller (*Closing*): In reading my manuscript I omitted a few paragraphs, one of which related to the position of the hip. I have not attempted to allow for any flexion at the time of operation or application of the spica dressing. This is explained in the paper.

Certainly tuberculosis seems to be arrested in some cases following simple exploration. In one case where I thought we were draining a Brodie's abscess in the femoral neck a tuberculous process was encountered. This hip later fused spontaneously. Another child had a benign-appearing hip which was proved tuberculous by biopsy, but occurrence of mumps, measles and other complications postponed a possible fusion operation for a year and spontaneous fusion occurred.

Our mortality has been low, fortunately. This we think is due to meticulous care in preparing the patients and carrying them through the operation, guarding from hemorrhage and shock. We ask the anesthetist to notify us when an operation has been in progress twenty-five minutes and try to close shortly afterwards.

OSTEOGENIC SARCOMA

WITH REPORT OF CASES

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AN impetus to the investigation of bone tumors has been given to the profession by the Sarcoma Registry, which has undoubtedly brought about a clearer conception of this most complex subject. This great service of the College of Surgeons has not only been the means of saving many limbs which were formerly sacrificed through errors in diagnosis, but also has, I believe, been responsible for the saving of life in a small percentage by encouraging earlier diagnosis and treatment.

The classification of bone tumors by the Bone Tumor Registry, while subject to objections, as is any classification in our present state of knowledge, should be recognized in every discussion of the subject as the common denominator for a more general understanding; otherwise there will be a reversion to the chaotic status which existed prior to the establishment of the Registry, in which the tumor was designated from the histopathology as interpreted by the individual observer.

Tumors of the bone should be divided according to their origin, as follows:

1. Osteogenic, those derived from or composed of tissues or of cells, whose function it is to produce bone, as osteochondroma, possibly giant cell tumor and osteogenic sarcoma.

2. Non-osteogenic, those derived from tissues residing in bone, but whose function is not associated in any way with osteogenesis, as endothelial myeloma, myeloma, extraperiosteal sarcoma.

3. Metastatic, tumors which have been brought into the bone from primary tumors elsewhere in the body through the

blood stream, lymphatics or rarely direct invasion, as carcinoma, hypernephroma, etc.

The term "osteogenic" means derived from and composed of any tissue element or cell where function is employed in the process of bone growth or repair. Osteogenic must not be confused with "osteogenetic" which signifies the formation of the end product of osteogenesis, mature bone; therefore osteogenetic indicates the production of true bone. An osteogenic tumor may be composed of any of the elements observed in bone formation, myxomatous tissue, fibroblasts, osteoid, embryonic and mature cartilage and true bone. An osteogenetic tumor is, therefore, osteogenic, but an osteogenic tumor is frequently not osteogenetic or bone forming. Several of these elements are usually found in varying proportions with a more or less fibrous framework. Some of the tumors are almost entirely cellular while others have a more definite structure, but this does not always signify the degree of malignancy from a clinical aspect. The consistency and gross pathological appearance vary obviously according to the composition.

The records of 210 cases of bone tumors have been reviewed for this discussion; of these there were 66 osteochondromas, 23 giant-cell tumors, 20 endothelial myelomas, 47 osteogenic sarcomas, 3 extraperiosteal fibrosarcomas, 6 adamantinomas, 41 metastatic tumors, 4 myelomas.

The 47 osteogenic sarcomas alone are pertinent to this discussion, and as Kolodny has pointed out, no arbitrary classification can be made of various types of osteogenic sarcoma. Geschickter and Copeland, in a recent dissertation on tumors of the bone, also conform to the classification of the Registry, but divide osteogenic sarcoma on the basis of histopathology as follows: (1) primary chondromyxosarcoma, (2) secondary chondromyxosarcoma, (3) osteoblastic osteogenic sarcoma, (4) chondroblastic osteogenic sarcoma, (5) osteolytic osteogenic sarcoma. The first three they believe to be derived from precartilaginous connective tissue, the last two, from tissue subsequent to the development of cartilage.

In order to secure a more accurate survey of this complex problem, deductive diagnosis cannot be made from any one factor, but from a careful consideration of, (1) the clinical

FIG. 1. Primary chondromyxosarcoma of fibula. Patient living after amputation.

history, (2) physical findings, (3) roentgenogram, (4) gross and microscopical pathology. Of these the roentgenogram is the most important, but cannot and should not be relied upon alone.

After a careful analysis of our series of osteogenic sarcomas, taking into consideration all of the foregoing factors, we found that it was impossible to make all of our cases conform to the

FIG. 2. Secondary chondromyxosarcoma of five years' duration. Patient died following excision of tumor.

classification of Geschickter and Copeland, except only in a rather general way, but sufficiently close to warrant its use in this discussion. The distribution of the 47 osteogenic sarcomas under discussion may be enumerated as follows:

TABLE I

1. Primary chondromyxosarcoma	6
2. Secondary chondromyxosarcoma	6
3. Osteoblastic	17
4. Chondroblastic	3
5. Osteolytic	15
Total	47

The general analysis of the various interesting features will be illustrated by tables of each group, after which comments will be made to emphasize the more interesting clinical features.

TABLE II

PRIMARY OSTEOGENIC CHONDROMYXOSARCOMA

Case No.	*Age*	*Sex*	*Symptoms*	*Trauma*	*Duration*	*Location*	*Treatment*	*Result*
I	21	M	Pain. Tumor Temp.	Yes	6 months	Rt. tibia	Amputation. *X*-ray	Died
II	14	M	Pain. Loss of weight	Yes	2 months	Lt. femur	Coley's fluid. *X*-ray	Died
III	51	M	Tumor. Pain	Yes	30 months	Lt. fibula	Amputation	Living
IV	38	M	Tumor	No	24 months	Chest wall	Partial excision	Died
V	19	M	Pain. Tumor	Yes	8 months	Rt. tibia	Amputation	Living
VI	44	M	Pain	Yes	20 months	Sacrum	None	Died

As the name implies, this tumor is composed of cartilage and connective tissue in various stages of development, the embryonic myxomatous tissue being observed in varying degrees. The tumor begins in the tendon insertions in the vicinity of the joints, subperiosteally and does not apparently invade the bone in the early stage. Some of our cases showed some ossification, but the chondromyxomatous tissue predominated. Bone production was so apparent in Case III as to lead to the question of the advisability of placing it in this group. The main characteristic of this tumor is that it is to a large degree invisible roentgenographically in the early stage, and, even in the late stage the roentgenogram does not define the extent of the new growth; therefore, diagnosis is too frequently delayed until there has been extensive progress or metastasis.

In Case I operation was performed for a displaced cartilage three months previously, without relief of symptoms, and when first observed we were very doubtful as to the diagnosis, which was not made until

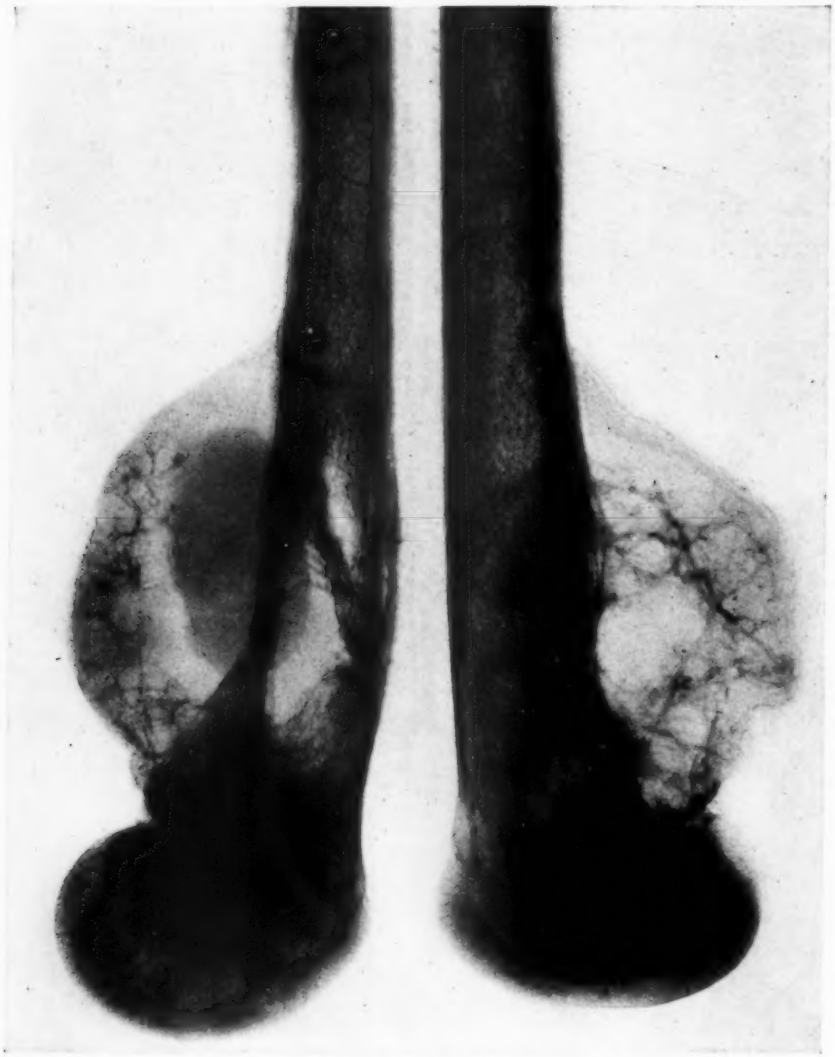

FIG. 3. Secondary chondromyxosarcoma. *X*-ray of specimen after amputation. Patient still alive.

biopsy. The roentgenogram showed slight, if any, changes within the bone suggesting tumor. The gross tissue was gray and semicartilaginous in appearance and quite typical of sarcoma, which was confirmed at once by the microscopic section. In Case II the diagnosis was somewhat dif-

ficult as the location in the neck and head of the femur is rather unusual. One diagnostic feature was present in this case which we have often noticed in osteogenic sarcoma and that is that traction, which usually allays

FIG. 4. Osteoblastic osteogenic sarcoma of femur. Amputation performed and Coley's toxin administered. Patient died.

symptoms in inflammation, greatly aggravated the symptoms, and this is often also true of any type of fixation. The location in Case IV was on the chest wall, a very large tumor the size of a grape fruit and of cartilaginous consistency. On attempted excision it was found that the ribs and inter-

costal spaces were involved to such a degree as to render complete excision impossible. From the history of this tumor it was thought that possibly the condition was originally a benign chondroma, but from the clinical course it has been thought best to place it in this group, the process being of only five years' duration from the time of onset to that of death by metastasis.

Out of the 6 cases two patients are living.

In Case III, it is over six years since amputation but this man was fifty-one years of age at the time of operation, and it is well known that the chances of recovery by radical treatment increase materially as age advances. The patient in Case V, aged nineteen years, is also living and well three years after amputation, but in this case there was a history of two previous attempts to excise locally, and the tumor was composed of more advanced cartilage than is found in the average specimen, a type of tumor which has been described by Phemister and others as chondrosarcoma which is relatively less malignant. The patients in Cases I and II, who were fourteen and twenty-one years old respectively, though amputation was performed before pulmonary metastasis developed, died three and four months respectively after amputation.

TABLE III

SECONDARY OSTEOGENIC CHONDROMYXOSARCOMA

Case No.	*Age*	*Sex*	*Symptoms*	*Trauma*	*Duration*	*Location*	*Treatment*	*Result*
I	38	F	Pain. Tumor	No	6 months	Mandible	Excision	Living
II	58	M	Pain. Deadness	Yes	12–15 years	Lt. femur	Amputation	Died
III	31	F	Pain. Tumor	No	5 years	Lt. femur	Excision	Died
IV	38	M	Pain	No	15 months	Lt. fibula	Amputation	Living
V	28	F	Pain. Tumor	No	12 months	Rt. femur	Amputation	Living
VI	26	F	Pain. Dysfunction	Yes	9 years	Rt. femur	Excision	Died

As the name implies, these are osteogenic sarcomas that have arisen at the site of lesions which were formerly benign, as low-grade osteitis, chondroma and osteochondroma. It is doubtful that these tumors undergo malignant degeneration, but in all probability they arise from dormant embryonic rests within the tumor. These cases all give a history and evidence of having existed in a more or less quiescent state for a long period of time, usually from five to ten years, or more. The

histopathology of the new growth is identical with that of the primary chondromyxosarcoma. The roentgenogram usually indicates a lesion of long duration in which an active process is progressing rapidly. As is obvious these do not possess uniform histopathology, but the clinical course is analogous in that they occur at a more advanced age and apparently secondary to a benign lesion.

The primary lesions in Cases III, V and VI (women) from the appearance as demonstrated by the roentgenogram were benign osteochondroma. Rapid increase in size with pain had been of recent occurrence. The roentgenogram demonstrated in each case a degenerative lesion within the tumor. Case III and VI were thought probably benign until local excision was attempted; amputation at the hip was declined in each case and death ensued. Two of these were histologically typical fibrosarcomas. No evidence of cartilage or derivation thereof were observed but as the clinical course so clearly resembled secondary chondromyxosarcoma they were placed in this group. The ages of these three averaged thirty years. The patient in Case V is living and well, four years after amputation. Case I is a rather atypical tumor of the jaw in which there have been two excisions, with one recurrence. The patient is still living and apparently healthy awaiting the completion of plastic bone graft operations. The end result, of course, cannot be considered at this time.

Case II is most interesting. A white man, aged fifty-eight, gave the history of having received a slight injury of the left thigh when playing tennis twenty years previously; since that time there had been occasional pain, at times rather severe. This patient was first examined November 28, 1926, and stated that since February the pain had become very intense, indefinite in character, boring, and involving the left thigh. There was no history of fever. On inspection there was an enlargement on the anterolateral aspect of the thigh just above the knee joint. On palpation there was a definite mass of osseous consistency and continuous with the femur. The roentgenogram demonstrated an enlarged and sclerotic femur with some breaking through and degenerative changes in the lower third. The evidence was suggestive, but by no means definitely characteristic of malignancy. At biopsy the tissue removed from the medulla resembled low-grade chronic inflammatory tissue in which there were some osteoid changes. There was no tumefaction exterior to the bone. The pathologist differed, but at the end of three weeks the tumor was growing rapidly, and amputation was performed, after which there was a general metastasis with death at the end of four months. After amputation there was no question

as to malignancy (chondromyxosarcoma). This case is reported more in detail on account of the unusual history and roentgenographic appearance.

In Case IV the patient is living and well thirteen years after amputation. The tumor was shown in two attempted excisions to be lobulated with fibrous tissue separating the lobes of typical hyaline cartilage. After the second operation there was early recurrence and rapid growth which proved after amputation to be a chondromyxosarcoma.

TABLE IV

OSTEOBLASTIC OSTEOGENIC SARCOMA

Case No.	*Age*	*Sex*	*Symptoms*	*Trauma*	*Duration*	*Location*	*Treatment*	*Result*
I	9	F	Pain. Tumor	Yes	2 months	Rt. femur	Amputation	Died
II	14	F	Pain. Stiffness	Yes	10 months	Rt. femur	*X*-ray	Died
III	7	M	Pain. Tumor	No	3 months	Lt. femur	*X*-ray	Died
IV	18	F	Pain	No	4 months	Rt. femur	Amputation	Died
V	12	F	Temp. Pain.	No	9 months	Lt. femur	Amputation	Died
VI	29	F	Pain. Tumor Tumor	No	72 months	Lt. femur	Amputation	Died
VII	18	M	Pain. Tumor. Temp.	Yes	9 months	Rt. femur	None	Died
VIII	19	M	Pain. Temp.	Yes	36 months	Rt. femur	None	Died
IX	12	M	Pain	No	2 months	Lt. tibia	Amputation	Died
X	21	F	Tumor. Pain. Fluid	Yes	12 months	Rt. femur	None	Died
XI	36	M	Pain. Tumor	Yes	48 months	Rt. femur	None	?
XII	36	M	Pain	No	24 months	Rt. femur	Amputation. Coley's serum	Died
XIII	12	M	Pain. Tumor. Limp	No	5 months	Lt. femur	Amputation. *X*-ray	Died
XIV	21	F	Pain. Tumor	No	10 months	Rt. femur	Amputation	Died
XV	20	M	Pain. Tumor	No	8 months	Lt. femur	None	Died
XVI	74	F	Pain. Tumor	No	4 months	Lt. tibia	None	?
XVII	6	M	Pain. Tumor	No	12 months	Lt. femur	None	Died

This type obviously signifies the preponderance of bone formation or production. Also there may be found, as in most osteogenic sarcomas, areas of soft structure composed of embryonic preosseous connective tissue in various stages of development. The appearance as observed by roentgenogram varies to some extent; the more common type shows the shaft in the early stage intact or only slightly involved, the tumor surrounding the shaft. New bone, especially in children, may

be deposited in fine spicules at right angles to the shaft, giving the so-called sun rays. At the extremities of the tumor when there is an elevation of the periosteum there may be so-called

FIG. 5. Osteolytic osteogenic sarcoma with pathological fracture of humerus. Amputation performed and *x*-ray treatments given. Patient died.

lipping or osseous projection in the direction of the tumor. The involvement of the shaft is often manifested by areas of opacity or condensation. Although the roentgenogram may not show involvement of the shaft the medulla is usually filled with osseous tumor tissue. This tumor may also be manifested by

condensation and osseous enlargement of the shaft or by an asymmetrical mass which shows numerous areas of osseous tissue. The occurrence is notably more frequent in youth,

FIG. 6. Osteolytic osteogenic sarcoma in woman forty years of age. Treated by *x*-ray. Patient died.

between the ages of ten and twenty-five years, in our cases, with the exception of one, aged seventy-four, the average being 18.9 years. This tumor is thought to arise from the osteogenic

layer of the periosteum and was once described by Bloodgood as periosteal osteosarcoma. This term has been entirely discarded by the Registry, and Bloodgood and others agree that in order

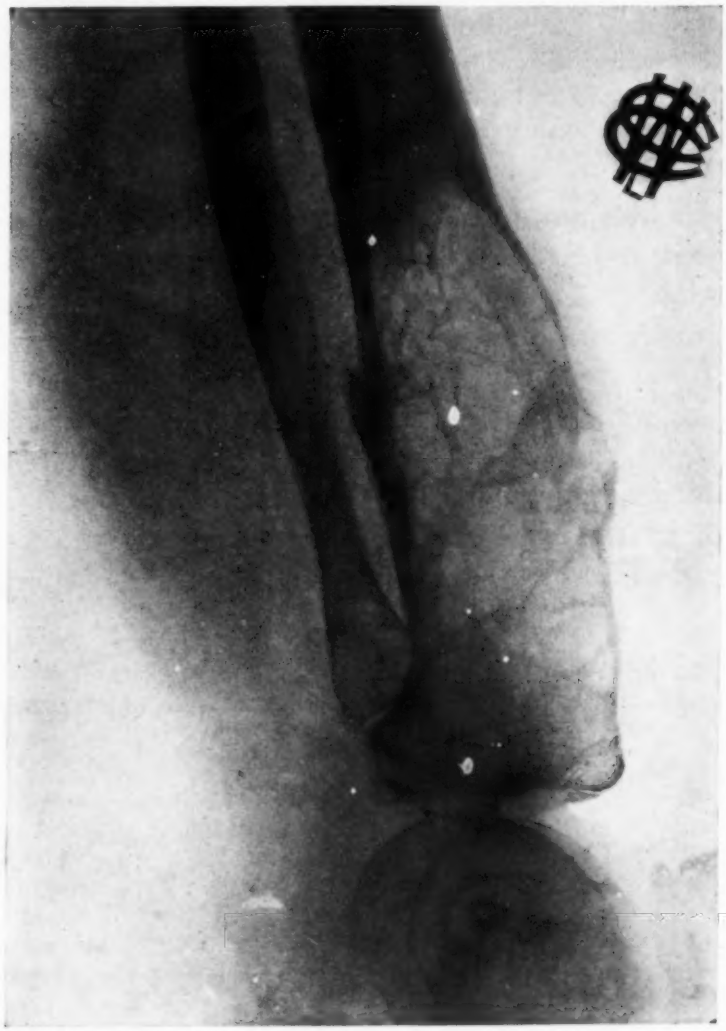

FIG. 7. Osteolytic osteogenic sarcoma of tibia.

to avoid confusion it should not be employed.

The distribution in this series is most interesting; of the 17 cases the femur was involved in 15, the lower third in 10, the upper third in 3 and the middle third in 2, the latter being a rather rare location for this type of tumor.

Case IX, age twelve years, demonstrates the more common type as afore-described, frequently observed in children. Case XII, aged thirty-six, shows the condensing type involving the shaft, with little if any periosteal change. Case XIV, age twenty years, demonstrates irregular osseous formation in an asymmetrical tumor. Cases XII and XIV are types which are more often observed in adults. Case V illustrates the occurrence of the tumor in the middle of the shaft, an unusual site. Case XI, age thirty-six, shows a low-grade tumor of four years' duration, which may possibly be secondary to a benign affair.

Geschickter and Copeland give a mortality of only 75 per cent, about 25 per cent remaining well five or more years after amputation. Much, however, depends on the age, duration at time of observation and selection of cases for classification in this group in estimating prognosis.

In this series of 17 cases, 14 patients are known to have died, and we have every reason to believe that the remaining three are dead as they cannot be traced, and treatment was declined. In this type mortality has been 100 per cent. The average duration of life from the onset to death was 16.9 months.

TABLE V

CHONDROBLASTIC OSTEOGENIC SARCOMA

Case No.	*Age*	*Sex*	*Symptoms*	*Trauma*	*Duration*	*Location*	*Treatment*	*Result*
I	22	M	Pain. Tumor	No	3 months	Rt. tibia	Amputation	Living
II	16	M	Pain	No	3 months	Lt. tibia	Amputation. *X*-ray. Coley's fluid.	Living
III	17	M	Pain. Tumor	Yes	7 months	Lt. tibia	Amputation	Died

This is of infrequent occurrence, at about the age of puberty, arising from the epiphyseal cartilage cells, and as its name implies is composed largely of embryonic cartilage cells; areas of calcification are also observed, from which the tumor was first described by Zieglers as petrifying sarcoma. The process involves the shaft but always penetrates the epiphyseal cartilage invading the disc. The tumor is distinctly osteolytic. There seems to be very little bone production, and in this it

closely resembles chondromyxosarcoma. Giant cells are often present and are probably reactionary osteoclasts, from which a giant-cell tumor has often been diagnosed. This type of tumor is not universally recognized by all authorities. In the early stage as in chondromyxosarcoma there may be no changes demonstrated by the roentgenogram. Later there are opaque areas of mottling and disintegration of the shaft and invasion through the epiphysis. In some cases reported by Geschickter and Copeland there have been cystic changes resembling giant-cell tumors, but this has not been observed in the cases herein discussed.

Case I, a man aged twenty-two years, gave a history of a small tender mass in the upper outer aspect of the right tibia, that was first noticed three months previously, had grown very slowly and became more painful at the end of two months from the time of onset. The roentgenogram was made in the Out-Patient Department of Baptist Hospital, and as no abnormality was observed the patient was told to return in one month when it was found that the tumor had grown more rapidly and symptoms were aggravated. A roentgenogram at this time demonstrated pathology suggesting malignancy. Amputation was done three months after the onset of symptoms. A comparison of the roentgenograms both before and after amputation shows astounding changes in so short a space of time. This patient is now living and healthy, seven months after operation. Biopsy and amputation were indicated one month earlier which would have probably given a better chance for recovery; however, we did not see the case at that time, and amputation was done immediately after the first examination.

Case II, a boy aged sixteen years, three months' duration, had a history practically the same as Case I. Amputation was performed, which was followed by Coley's serum. He is now living and well one year after amputation. Of course, the time is too early to comment on the probable result in either case.

Case III, a boy, aged seventeen, had a tumor in the same location but of indefinite duration, four to six months. He died of metastases one year after the onset of symptoms. He also received Coley's serum.

Osteogenic osteolytic sarcoma from a clinical aspect may be divided, according to age, into two groups: (1) children and young adults, (2) mature adults, usually above the age of thirty.

The occurrence of this type is more often between the ages of ten and twenty years; fever and leucocytosis are not uncommon, with at times lymphadenoma. There is some pain in the early stage before the cortex disintegrates, after this the pain is very little or may almost entirely disappear, which is evidently due to the relief of intraosseous pressure. In other

TABLE VI
OSTEOLYTIC OSTEOGENIC SARCOMA (IN THE YOUNG)

Case No.	*Age*	*Sex*	*Symptoms*	*Trauma*	*Duration*	*Location*	*Treatment*	*Result*
I	9	F	Pain. Tumor	No	12 months	Rt. clavicle	Excision	Died
II	33	M	Pain. Tumor	Yes	7 months	Rt. humerus	Excision	Died
III	22	M	Pain. Stiffness	Yes	8 months	Rt. tibia	None	Died
IV	18	M	Pain. Tumor	Yes	8 months	Lt. humerus	Excision. Coley's fluid	Died
V	10	M	Tumor	Yes	6 months	Lt. humerus	*X*-ray	Died
VI	24	M	Pain. Tumor Loss of weight	No	3 months	Lt. humerus	Amputation	Died
VII	15	F	Pain. Tumor	Yes	6 months	Rt. humerus	None	Died
VIII	17	F	Pain. Tumor. Temp.	Yes	3 months	Lt. femur	Amputation	Living
IX	16	M	Pain. Tumor	No	5 months	Lt. femur	None?	Living

types of sarcoma which increase in size within the unyielding shaft, intraosseous pressure is excessive with characteristic intense boring pain.

In the osteolytic osteogenic sarcoma fracture occurs in a large percentage, probably 50 per cent. The process begins in the medulla of the metaphysis from the endosteum and is very cellular, with often the formation of osteoid tissue throughout. There is such an enormous blood supply that the term "bone aneurysms" has been applied in the older literature, when this feature was exaggerated. The process at first is so insidious or rapid and there is usually such extensive destruction that by the time the patient is first examined there has been complete disintegration of bone surrounded by a mass of soft tissue tumor. This may be so extensive that the entire extremity of the bone may have disappeared.

On physical examination there is a definite regular mass surrounding the bone, which is not especially tender to pressure. The occurrence is by far more frequent in the upper third of the humerus. Of the 9 cases reported there were 5 in the upper extremity of the humerus, 2 in the upper extremity of the femur, 1 in the upper extremity of the tibia and 1 in the mid-third of the clavicle.

In the early stages the *x*-ray may show only central disintegration with a cavity which may resemble a cyst, but usually when the patient is first observed there is complete disintegration of the shaft, without osseous reaction on the part of the bone or periosteum. However, after a pathological fracture there may be some evidence of callus. The appearance is so characteristic that diagnosis can usually be made by the roentgenogram alone. The mortality in this group, as was seen in the osteoblastic group, is very high. In fact all patients have died of metastasis within from five months to one year after observation or amputation. Two are living but only a short time after treatment was instituted.

TABLE VII
OSTEOGENIC OSTEOLYTIC SARCOMA (ADULTS)

Case No.	*Age*	*Sex*	*Symptoms*	*Trauma*	*Duration*	*Location*	*Treatment*	*Result*
I	22	M	Tumor	Yes	5 months	Lt. tibia	Excision	Living
II	33	F	?	...	?	Lt. femur	None	Died
III	35	F	Tenderness. Limp	No	6 months	Lt. tibia	Amputation. *X*-ray	Died
IV	30	M	Tenderness. Dysfunction	No	12 months	Lt. femur	Amputation. Coley's serum	Living
V	40	F	Pain. Loss of weight	No	48 months	Lt. femur	*X*-ray	Died
VI	39	F	Swelling	Yes	5 months	Lt. tibia	.....	?

This to me is an entirely different tumor from the osteolytic type in the young, which may possibly be due to difference in manifestation in tissues at different ages of development. However, the pathological appearance in our cases was also different. The histopathology in three was that of fibrosarcoma,

as is often observed in sarcoma involving the soft tissues at any location in the body, as the fascias. In the other three the pathological report was "osteosarcoma" in one and "round-cell sarcoma" in two. These terms are obsolete and do not conform to the classification of the Registry.

The onset and evolution of this tumor is very slow and insidious. Geschickter suggests the probability that it is secondary to some other process. The location in the metaphysis is the same as in the osteolytic type in the young, but remains largely confined within the shaft for a much longer period of time, often many years. There is often, however, a penetration of the shaft, with irregular tumefaction, externally, but we have never observed in this series the extensive tumefaction surrounding the disintegrated shaft as is observed in the osteolytic type in the young. Also the occurrence as regards the bones involved is different. In the young the osteolytic type was found most frequently in the upper extremity of the humerus, whereas in the adult type this bone was not involved in a single case, the distribution being: tibia 3, lower third of femur 2, upper extremity of femur 1. This type has often been mistaken for giant-cell tumor, which is found largely on the side of the epiphyseal disc, and there is not as a rule the multilocular cystic appearance observed in giant-cell tumor. Also the cortex is more frequently penetrated by the tumor. Bone cysts are more regular and usually involve almost the entire cortex, never break through except when there is a pathological fracture nnd then do not involve the soft parts. Also there is more general expansion of the shaft. The clinical course can be best illustrated by a consideration of the clinical behavior of the cases.

Case 1, a man, aged twenty-two, seen February 21, 1923, had had a slight injury to the ankle four months previous. There was some pain for two weeks which disappeared. After a few more weeks pain appeared with swelling which has persisted to the present time. On examination definite swelling, enlargement of bone, and tenderness were present. A roentgenogram demonstrated a definite osteolytic process of central

location in the tibia above the ankle joint. Biopsy showed grayish solid indurated tissue which did not fill the entire cavity. Report: fibrosarcoma; amputation. The patient is living and well at the present time, nine years after amputation. From the history of so slight an injury it is possible that a bony lesion may have existed prior to it.

Case II, a woman, aged thirty-three, November, 18, 1917, gave a history of tumor lower third right femur, of eight years' duration, in which there was recent exacerbation of symptoms and increased growth. Biopsy, "osteosarcoma"; amputation with death from metastasis within one year. There is evidence in this case of secondary involvement of a benign process.

Case III, woman, aged thirty-five, October 1, 1929. The onset was indefinite, in the spring of 1929. Examination showed a slight swelling of the upper extremity of the left tibia medial to the anterior tubercle, with tenderness. A roentgenogram showed a destructive process of the upper end of the left tibia; a tendency to small cavity formation, some periosteal thickening. Biopsy: fibrosarcoma, but apparently not very malignant. Amputation was performed in the mid-thigh followed by recurrence in the ilium with death approximately two years after onset.

Case IV, a man, aged thirty, May 21, 1931. Injury had occurred one year previous, and then had been a gradual onset of pain and swelling in the lower third of the right thigh. Examination showed a tumor of the lower third of the right femur, more pronounced in the popliteal space. A roentgenogram showed a destructive process in the lateral condyle of the right femur involving the lower 6 inches of the shaft, multilocular cysts with erosion of the cortex. Biopsy: fibrosarcoma. The patient is living and well eighteen months after amputation.

Case V, a woman aged forty, September 13, 1930. The onset occurred four years previously, with recent exacerbation of pain and swelling in the region of the trochanter of the left hip. A roentgenogram showed a central destructive lesion in the trochanter. Biopsy: fibrosarcoma. Amputation or excision was declined. She died of metastases, January 26, 1931.

Case VI, a negro woman aged thirty-nine, May 15, 1923, had had pain and a knot in the leg for about one year, when in July, 1922 she fell about 2 feet, and thought the leg was broken, as she could not walk, except with the aid of crutches, for several months. The leg was again injured about January 23, since which she had used crutches. The left upper third of the tibia was enlarged with a definite growth of soft structures about this portion of bone, tender on pressure. *X*-ray showed multiple cystic changes in the upper third of the left tibia, apparently an old fracture through the tumor. Tentative diagnosis: giant-cell tumor or bone cyst. Operation: An incision was made over the tumor in the left tibia. The tip of bone was

found expanded and within a thin cortex of bone was a soft tumor, pale gray in color and containing no bony material. It was not the color nor did it have the appearance of giant-cell tumor but appeared more malignant. The cortex had been eroded through the lateral and posterior surface and there had been a pathological fracture. The tumor was curetted out of the bone cavity and the wound closed. There was no involvement of soft tissues. Report: "round cell sarcoma." After careful examination and consultation, amputation was performed on May 24, 1923. The patient is living and well nine and one-half years thereafter. This might be regarded as doubtful as to malignancy, but from the evidence we believed amputation advisable.

Of the 6 patients there are 3 living and well at the present time, 2 of whom have passed the five-year period. The mortality and clinical symptoms are obviously in marked contrast to the osteolytic type in the young.

This series of osteogenic sarcoma from a practical clinical aspect may be divided into three general groups: (1) primary chondromyxosarcoma, osteogenic osteoblastic sarcoma, osteogenic chondroblastic sarcoma and osteogenic osteolytic sarcoma in the young. The clinical behavior, age, duration and progress are approximately very closely related and it is very doubtful, as already stated, whether differentiation is warranted. (2) Secondary osteogenic sarcoma, already described as secondary chondromyxosarcoma, in our series of varied structure and running a much longer course and with a more favorable prognosis. (3) Osteogenic osteolytic sarcoma in the adult is also of longer duration and far better prognosis. This type of sarcoma was described in the older literature as a central or medullary type, which was known to be distinctly less malignant. It is also possible that many tumors diagnosed as of the central or medullary type of sarcoma were in reality bone cysts or giant-cell tumors, which might obviously render prognosis apparently, though not in reality, more favorable.

Of the 47 osteogenic sarcoma, 35 were of group 1; of these patients there are 6 living and only one who has passed the five year period, and he was fifty-one years of age at the time of operation. One with the chondroblastic type, aged seventeen, is living and in good health at the end of one year after

amputation and Coley's serum, which is only slightly encouraging. One aged twenty-two, whose tumor was pathologically not very malignant, being composed largely of adult cartilage, is living at the end of three years. In the remaining 3 sufficient time has not elapsed to draw conclusions. In groups 2 and 3, an aggregate of 12 cases, there are 6 patients living and healthy, 3 of whom have passed the five-year period, one four years and others of less duration. The details of these have been previously discussed.

Age Classification: Age alone also may be made a basis of classification from the clinical course and prognosis, as all patients who had passed the five-year period, with one exception, were mature adults at the time of amputation.

In our series there were 30 amputations or radical excisions and 17 patients who declined any form of radical treatment and in whom no result other than death could be expected. In a large majority the process was well advanced when first observed, as many of the patients were from rural districts and did not present themselves to the family physician until several months had elapsed. As previously mentioned in this series we are only dealing with osteogenic sarcoma, but differential diagnosis must always be made from other types.

The roentgenogram is the most valuable agent by which diagnosis can be made in typical cases the manifestations of which cannot be satisfactorily described in writing. Accuracy in interpretation can be acquired only by experience in the observation of many cases. Differentiation can be made between typical cases of various types of tumors, but in some instances this may be impossible, for instance, endothelial myeloma (Ewing's tumor) with extensive destruction may so closely resemble osteolytic osteogenic sarcoma in the young that differentiation can be made only by biopsy and history.

X-ray treatment in osteogenic sarcoma was of no material value, except that in a small number there were induced osseous reactive changes. *X*-ray treatment was used in all cases as a

postoperative measure, but it has been difficult to estimate any beneficial action. Coley's serum has been employed in a number of osteogenic and other types of bone sarcoma but sufficient time has not elapsed to estimate the results.

The question of malignancy in all bone tumors is one of degree. There is no type of bone tumor which has ever been described in which there is not a possibility of such changes, therefore all tumors of bone as illustrated by the number of secondary lesions in this series must be regarded as potentially malignant.

While it is often true that regardless of how early the case is observed the result may be metastasis or death, a great majority are not seen until very late. In consequence there is no evidence available as to what may be accomplished if a large number could be seen while incipient. It is also apparent that the secondary sarcoma, and the osteolytic sarcoma in adults could be diagnosed at a much earlier period if closer attention was paid to osseous lesions of a chronic nature. The same attention and propaganda in bone sarcoma by the profession and layman is needed as that now given in cancer elsewhere. It is now recognized that many cancers are cured by early treatment and the same may be true of malignant tumors of bone, by proper education of the profession and the public to regard all swelling, tumefaction or persistent pain in a bone of serious consequence until proved otherwise. When one considers the varying degrees of malignancy existing in different types, there is no wonder that estimates of results in considering bone sarcoma as a whole are most unreliable, and also it is quite apparent that the most malignant types are seen too late. It is now impossible to estimate what might be accomplished with radical or other treatment instituted at an earlier stage. By our present methods of treatment there is no possibility of cure in a high percentage, but the percentage of excellent results could in all probability be materially increased with radical procedure instituted in the incipient stages.

DISCUSSION

Dr. Barney Brooks, Nashville, Tenn.: I wish to compliment Dr. Campbell on his exact definition of the word, "osteogenic." I wonder, however, if it would not be better if we made use of another term. Unfortunately, the suffix, "genic" was first used by Lavasoir incorrectly, and consequently is frequently used in the sense of *producing* rather than *originating from.*

I wish, also, to take this opportunity of urging all members of this Association to register their cases of bone sarcoma with the Committee on Bone Sarcoma of the American College of Surgeons. The value of the material accumulated by this committee is in direct proportion to the carefulness of the study of the registered cases. The material, coming from the members of this Association would, therefore, be particularly valuable.

Dr. Robert L. Rhodes, Augusta, Ga.: At the Pinehurst meeting, in 1921, I presented a paper before the Association on "Periosteal Sarcoma in Association with Osteomyelitis" in which I reported 3 cases, 2 patients living and one dead. These cases have been reclassified and placed in the group in which, as Dr. Campbell stated, practically 100 per cent are fatal. I think the same is true of Bloodgood's report. I wish to make a supplemental report on that paper at this time. In Case III the patient died with definite pulmonary metastases about four months after the paper was read. The other patient, operated on March 16, 1921, is still living and well eleven and three-quarter years since operation and, so far as I know, and according to my last talk with Dr. Bloodgood about it, this is the only case on record of that group that is well.

One point I brought out in that paper was that at the time of the exploration of the growth in this fourteen-year-old girl, in whom symptoms had existed for about six months, I placed a tourniquet just above the knee, had a definite diagnosis by exploration and frozen section and immediately amputated above the tourniquet which had been placed above the knee, placing an additional tourniquet higher up and operating between the two so that the lower tourniquet would prevent any deposit of cells dislodged below. A complete change of operative toilet was instituted between the exploration and the amputation.

Dr. Willis C. Campbell (*Closing*): The same careful observation of those with suspicious bone lesions should be made as is advocated in suspicious lesions of the breast, uterus and elsewhere. This can only be accomplished by frequent examination with roentgenograms when there is the slightest symptom or sign suggesting an affection of the bone. Whenever there is a low-grade or chronic pathological process in the bone the patient should be urged to report the slightest symptom suggestive of an

active process regardless of the length of time that process may have been dormant, as is demonstrated by the secondary osteogenic sarcoma reported.

There are very few cases reported of primary osteoblastic or osteolytic sarcoma in the young in which the patients have survived the five-year period. All my patients as just reported have died.

As regards Dr. Rhodes' case: I do not think we can accept unequivocally such a diagnosis unless the specimen in his case has received the confirmation of the Sarcoma Registry, or of other pathologists of experience in this special field; for eleven or twelve years ago our knowledge was so chaotic as to render most of our diagnoses on those who survived as questionable. I assume that Dr. Rhodes has had a more recent review of the slides and re-examination of tissue, and therefore, desire to congratulate him on his fortunate result.

I thoroughly agree with Dr. Barney Brooks that all cases should be registered with the Sarcoma Registry of the American College of Surgeons, I have done this in all cases since its establishment.

EFFECT OF ROENTGEN RAYS ON BONE GROWTH AND BONE REGENERATION

AN EXPERIMENTAL STUDY*

BARNEY BROOKS, M.D. AND HARRY T. HILLSTROM, M.D.†

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DURING the first year after the discovery of the *x*-rays, it was observed that this form of energy produced profound changes in living matter. In 1903 Perthes found that the growth of one wing of a chicken was greatly diminished if this wing only were exposed to the influence of roentgen rays when the chicken was one day old. Since the appearance of Perthes' report, numerous investigators have recorded their observations concerning the influence of the roentgen ray on the growth of bones in animal experiments and also from the therapeutic use of the roentgen ray. From a careful review of all the available literature it seemed that there was as yet a sufficient lack of clearness concerning the amount of irradiation necessary to inhibit the growth of bone, the quantity of the effect produced, the duration of the influence, and the coincident histological changes, to justify the repetition of many of the experiments previously performed.

The possibility of inhibiting or stimulating regeneration of bone has also been investigated by experiments upon animals and by observations upon patients with bone defects due to trauma or other disease. From previous studies it seems as if it were definitely determined that extraordinarily large doses of irradiation have little or no effect on the capacity of a bone to regenerate new bone. There is a conflict of opinions concerning the stimulating effect of the roentgen ray on new bone formation, but it would seem as if the maximum stimulating effect which had been observed is not sufficient to be of importance.

* From the Department of Surgery, Vanderbilt University.

† Deceased.

The number of experiments which are the basis of this paper is too large for a detailed report. Only the experimental method and the results obtained in several groups of experi-

FIG. 1. Photograph of bones of forearms of dog five months old in which right radius and ulna and distal end of right humerus were exposed to standard dose of irradiation. Note difference in length of bones of right and left forearms and particularly difference in size of distal ends of right and left humerus.

ments will be briefly summarized, and particular attention given to the results obtained in a group of experiments performed for the purpose of studying some factors which have not been previously discussed.

EXPERIMENTAL METHOD

Young rabbits were used in most of the experiments. In a few experiments dogs, guinea pigs, rats and mice were used. No important difference was observed in the results obtained in these different animals. In each group of experiments, one or more litters of young rabbits were used. As far as possible, each litter of rabbits was cared for in such a manner that each rabbit of a litter was subjected to the same environment except for the age at exposure and the amount of irradiation.

The factors constituting the standard dose subsequently referred to as 100 per cent S.E.D., were as follows: 180,000 to 200,000 volts, 20 to 30 ma., 60 cm. target-skin distance, 0.5 mm. copper combined with 1.0 mm. aluminum filters, and forty-five minute exposure. The exposed fields varied from 1 × 2 cm. to 1 × 5 cm.

Either the right tibia or the right ulna and radius were exposed. The remainder of the animal's body was carefully protected with sheet lead. After exposure the animals were cared for on a suburban farm. At regular intervals varying from one to twenty-eight days, roentgenograms were made of both the exposed and the non-exposed extremities. In each instance the extremity was placed as near the film as possible and the *x*-ray tube at a distance of 7 feet from the film. Measurements in growth in length of the bones were made from the roentgenograms. In experiments designed for histological study, the exposed and non-exposed bones were removed, fixed in formalin, decalcified, sectioned and stained with hematoxylin and eosin.

I. EXPERIMENT ILLUSTRATING THE GROSS EFFECT OF EXPOSURE OF GROWING BONE TO ROENTGEN RAYS

The distal end of the right humerus and entire lengths of the radius and ulna of a dog four weeks old were exposed to a single 100 per cent S.E.D. with the technique previously described. Four months after exposure the animal was sacrificed. The effect on bone growth is illustrated in Figure 1.

From this illustration it is clear that there was a marked inhibition in the growth of those bones exposed to the roentgen rays. The right ulna increased 41 mm. in length and the left ulna increased 102 mm. in length. The fact that inhibition of bone growth occurs only in the bone which is within the field of exposure is apparent from comparison of the proximal and distal ends of the right humerus. Note also that the general contour of the bones in which growth has been inhibited is remarkably unchanged.

II. EXPERIMENTS SHOWING THE EFFECT OF EXPOSURE OF GROWING BONES TO THE ROENTGEN RAY IN DOSES SMALLER THAN THE STANDARD SKIN ERYTHEMA DOSE

The right tibiae only in a series of young rabbits were exposed to doses of roentgen rays estimated at 40 per cent, 60 per cent, 80 per cent and 100 per cent S.E.D. All animals receiving 40 per cent or more of the skin erythema dose showed definite inhibition of bone growth. Increasing the amount of irradiation always increased the amount of retardation of bone growth. The proportionate decrease in rate of bone growth was greater than the proportionate increase in dosage.

III. EXPERIMENTS DESIGNED TO TEST THE POSSIBILITY OF STIMULATING BONE GROWTH BY THE USE OF REPEATED IRRADIATION IN SMALLER DOSES THAN THAT WHICH PRODUCED INHIBITION OF BONE GROWTH

The right tibiae only in a series of young rabbits were subjected to various combinations of repetitions of roentgen-ray exposures estimated at from 2 per cent to 5 per cent of the skin erythema dose. The animals were observed over various periods of time and in no instance was any evidence obtained of stimulation of bone growth.

IV. EXPERIMENTS TO DETERMINE THE RESULTS OF REPEATED EXPOSURE TO DOSES OF ROENTGEN RAYS SUFFICIENT TO INHIBIT BONE GROWTH

The right tibiae only in a series of young rabbits were exposed to various combinations of repeated irradiation in doses sufficient to inhibit bone growth. The results of various combinations of amounts of irradiation, number of exposures, and time intervals between exposures were observed. The total quantity of irradiation received always produced less inhibition of growth the larger number of times the dose was divided or the longer the interval between the exposures. For example, 150 per cent S.E.D. given in 2 equal doses on successive days

had about the same effect as a single 100 per cent S.E.D.; while 160 per cent S.E.D. divided into 4 equal doses and given during a six day period was not as effective in inhibiting bone growth

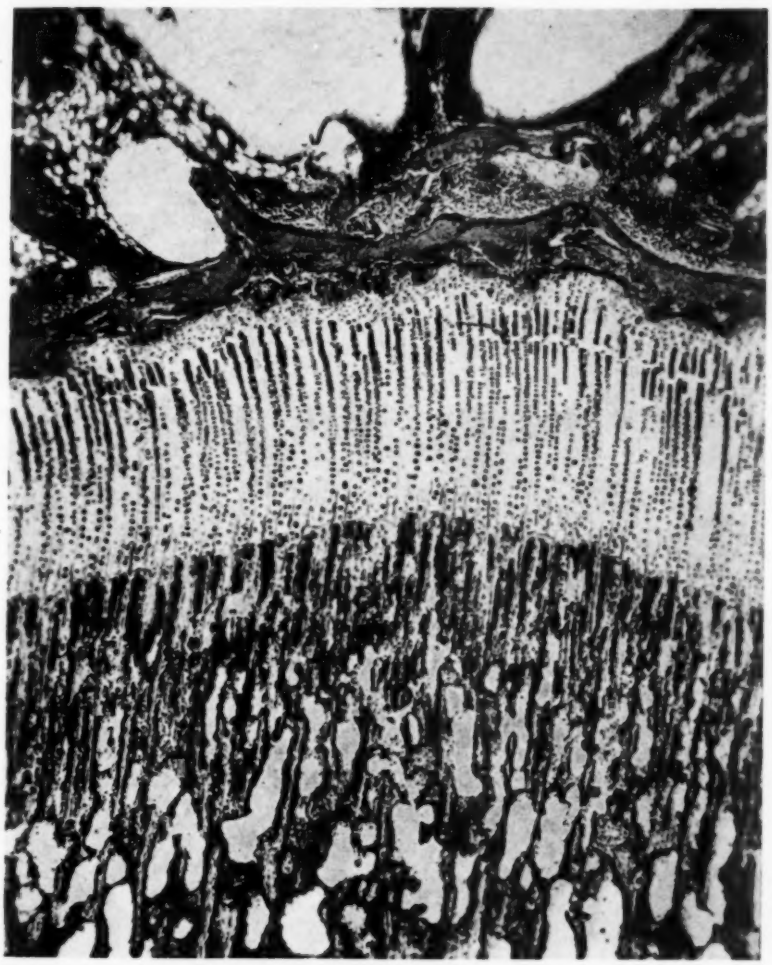


FIG. 2. Photomicrograph of longitudinal section of normal proximal epiphyseal cartilage of tibia of a rabbit twenty-seven days old.

as a single 100 per cent S.E.D.

V. EXPERIMENTS FOR THE STUDY OF THE CHANGES IN BONE AND CARTILAGE PRODUCED BY IRRADIATION

The right tibiae only in a series of young rabbits were exposed to the 100 per cent S.E.D. of the roentgen ray. The

animals were sacrificed at periods ranging from twenty-four hours to 148 days. The histological changes which occurred in the epiphyseal cartilage are illustrated in Figures 2, 3 and 4.

FIG. 3. Photomicrograph of longitudinal section of proximal epiphyseal cartilage of exposed tibia of same rabbit as illustrated in Figure 2, four days after receipt of 100 per cent S.E.D.

A detailed description of these changes will be reported in a separate paper.

In general it may be said that immediately after exposure of the epiphyseal cartilage to the standard 100 per cent S.E.D. there is marked evidence of serious damage to the cartilage

cells. The arrangement of the cells becomes irregular. Some cells are swollen and others are obviously disintegrated. Some cells appear normal and are regularly arranged. The irregu-

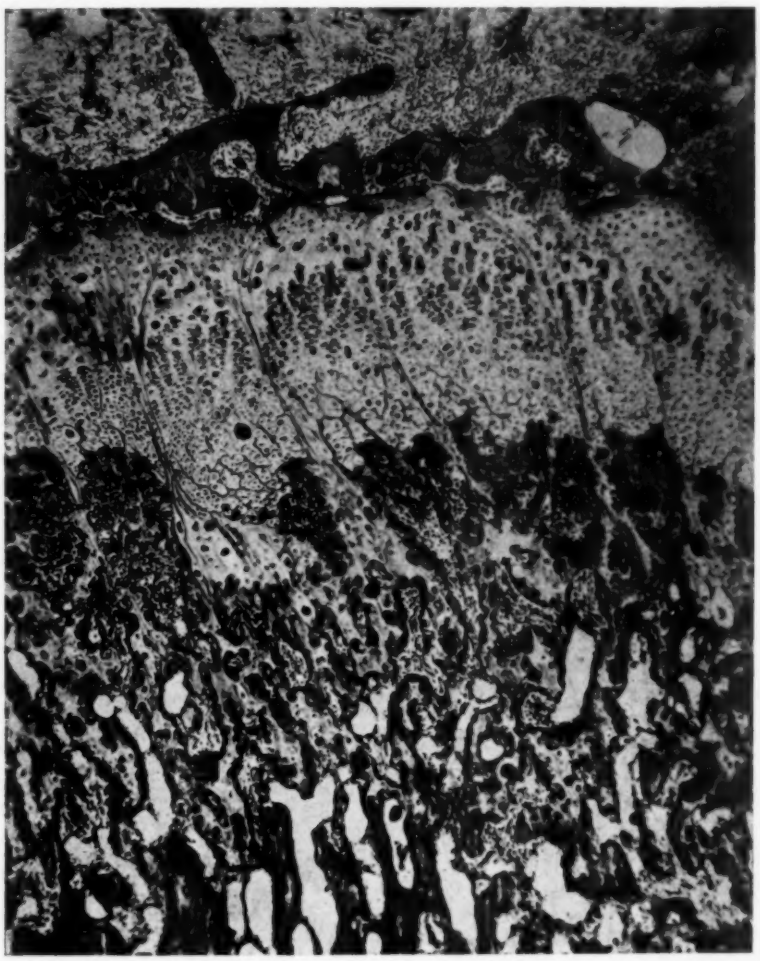


FIG. 4. Photomicrograph of longitudinal section of promimal epiphyseal cartilage of tibia of rabbit fifteen days after exposure to 40 per cent S.E.D.

larity of arrangement persists throughout the entire period of bone growth. During the latter part of the period of bone growth the epiphyseal cartilage becomes irregular in thickness. In some instances the cartilage disappears completely in some areas. It is particularly during this period that growth deformities develop.

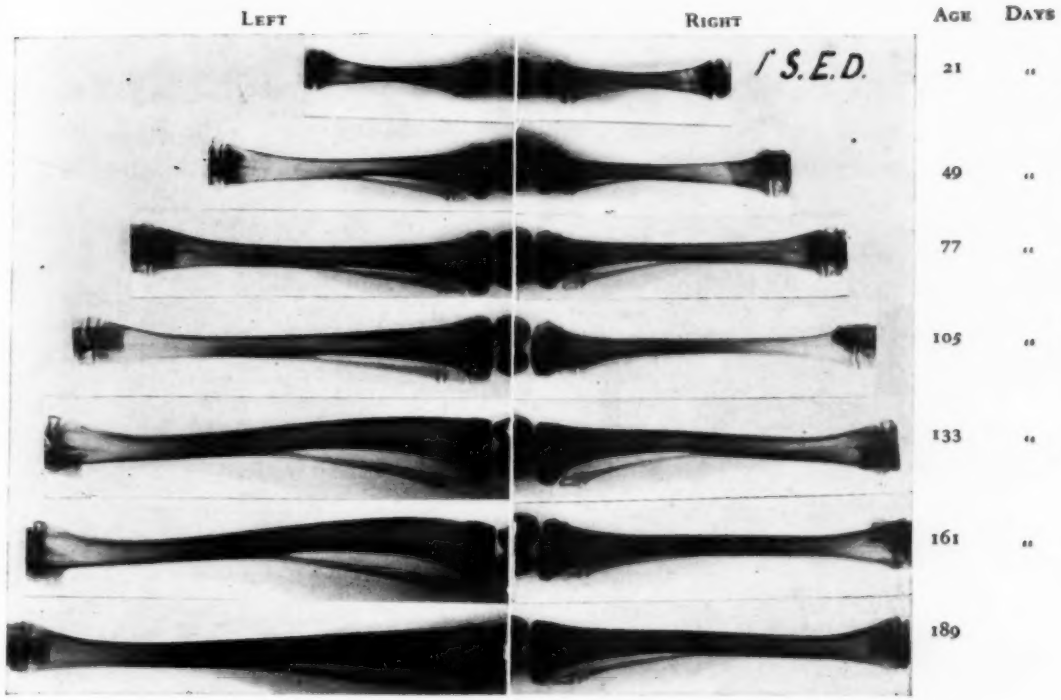
VI. EXPERIMENTS DESIGNED TO STUDY THE EFFECT OF IRRADIATION ON BONE REGENERATION

It has been previously pointed out by the author that growth in length and thickness of bones is a process which operates only during a limited period of life, and that the capacity of a bone to regenerate a defect is not limited to any period of life. It would seem, therefore, as if the two processes must be independent. Previous investigators have demonstrated that repair of bone was not perceptibly influenced by exposure to relatively large doses of the roentgen rays. For our own satisfaction, however, ten experiments were carried out on young rabbits. Equal defects in the right and the left ulna were produced by subperiosteal resections of the bone shafts. In each of the rabbits the right foreleg was exposed to the 100 per cent S.E.D. In some of the rabbits this exposure was made immediately after operation, and in others on the third to sixteenth day after production of the bone defect.

The animals were frequently observed throughout the process of repair. In each instance growth of the right ulna was inhibited. In no instance, however, was there any perceptible difference in the amount of new bone formation or in the duration or completeness of the process of repair. No experiments were performed in which smaller doses were used with the idea of stimulating bone repair.

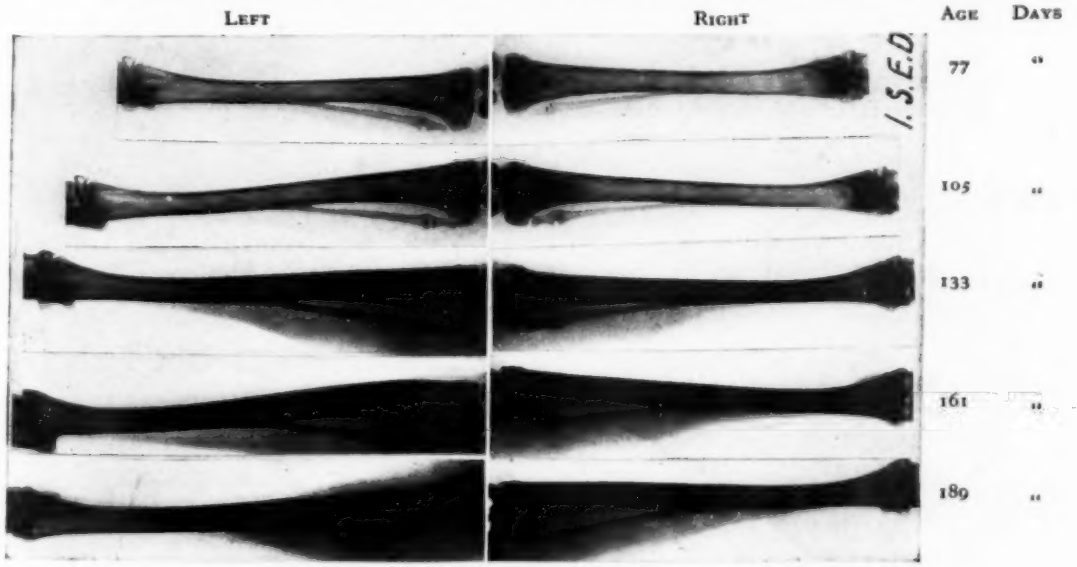
VII. EXPERIMENTS FOR DETERMINING THE INFLUENCE OF THE ROENTGEN RAY ON THE FORM OF THE CURVES OF GROWTH IN LENGTH OF BONES

Six white rabbits from the same litter, born May 14, 1932, were labeled A-1, A-2, A-3, A-4, A-5 and A-6. The entire right tibiae of rabbits A-1, A-2 and A-3 were irradiated on June 4, 1932 with 100 per cent S.E.D. All of the rabbits were kept as nearly as possible under the same conditions. The entire right tibiae of rabbits A-4, A-5 and A-6 were exposed to 100 per cent S.E.D. on July 30, 1932. Roentgenograms of both



Exp. A-2.

FIG. 5. Serial roentgenograms made at intervals of twenty-eight days in rabbit in which right tibia and fibula were exposed to 100 per cent S.E.D. at age of twenty-one days.



Exp. A-4.

FIG. 6. Serial roentgenograms made at intervals of twenty-eight days in rabbit of same litter as illustrated in Figure 5, in which right tibia and fibula were exposed to 100 per cent S.E.D. at age of seventy-seven days.

tibiae of all rabbits were made every twenty-eight days for six months. The results obtained in rabbits A-2 and A-4 are illustrated in Figures 5 and 6. The measurements of the lengths

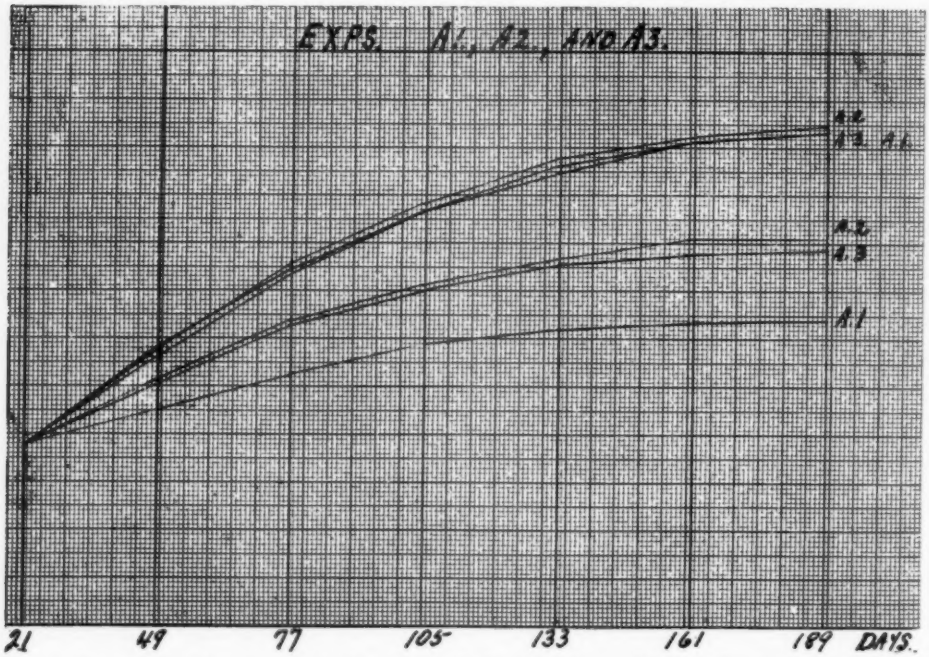


FIG. 7. Graph showing growth in length of shafts of right and left tibiae in three rabbits of same litter in which right tibiae were exposed to 100 per cent S.E.D. at age of twenty-one days.

of the shafts of both tibiae of all rabbits are shown graphically in Figures 7 and 8. Figure 9 is a graphic representation of the average growth in lengths of experiments A-2, A-3, A-5 and A-6.

A study of these curves reveals certain important facts which have not heretofore been discussed in the various reports dealing with the effect of the roentgen ray on the growth of bone:

Growth in length of the shaft of the normal unexposed tibia was remarkably constant in all of the six rabbits. The contour of this curve in general corresponds with "growth curves." The rate of growth is greatest during the earlier periods and decreases geometrically to zero in the later periods.

An attempt was made to fit this curve to a simple equation. It became easily apparent that any equation which would even approximately reproduce the curve would have a complexity

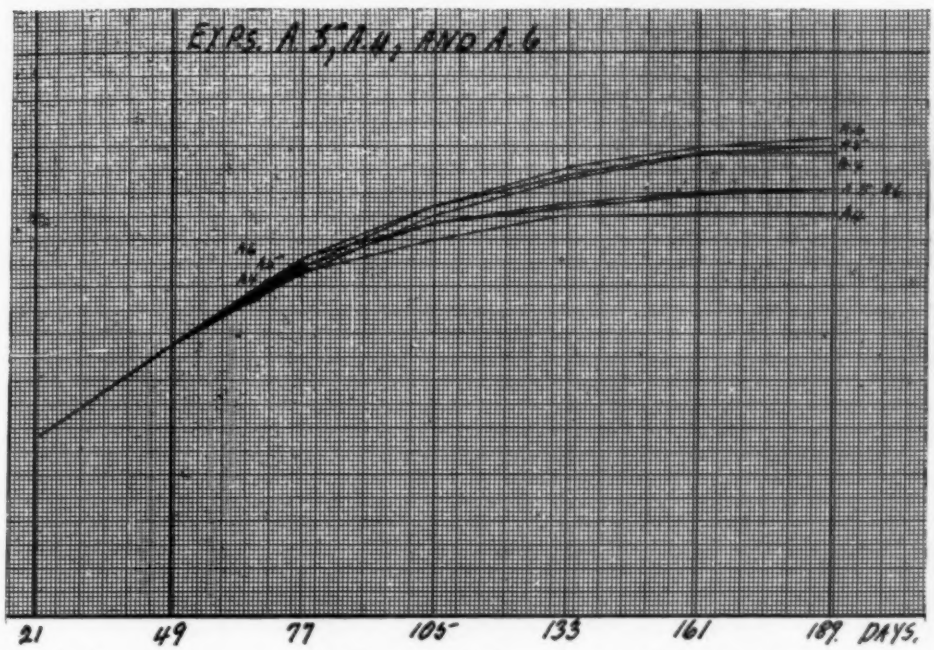


FIG. 8. Graph showing growth in length of shafts of right and left tibiae in three rabbits of same litter in which right tibiae were exposed to 100 per cent S.E.D. at age of seventy-seven days.

entirely out of proportion to the accuracy of the experimental method.

The fact, however, that suitable simple equations for curves cannot be obtained for comparison does not preclude the possibility of obtaining valuable information by comparing the general contours of the curves themselves.

In Figure 7 it will be noted that the growth in length of the unexposed tibiae in rabbits A-1, A-2 and A-3 was nearly the same. Also the growth in length of the exposed tibiae in rabbits A-2 and A-3 was nearly identical. The growth in length of the exposed shaft of the tibia in rabbit A-1 is much more abnormal than that occurring in the exposed tibiae of rabbits A-2 and A-3, in spite of the fact that presumably the same amount of

irradiation was used at the same age. On going back over the protocols of the experiments, it was interesting to find that rabbit A-1 was first treated, and it is possible that a gross

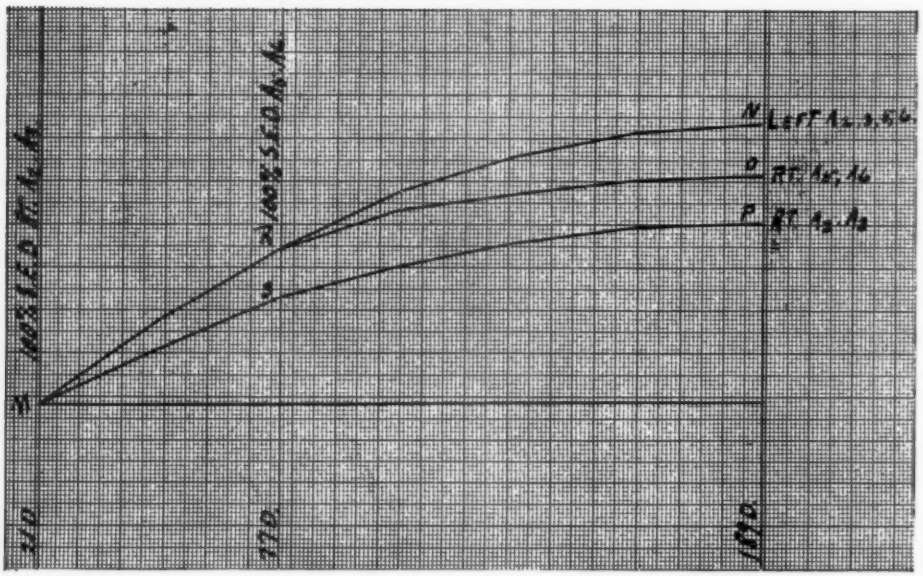


FIG. 9. Graph showing average length of right and left tibiae in rabbits A-2, A-3, A-5 and A-6.

inaccuracy occurred in the estimation of the dosage used. This supposition is supported by examination of Figure 8 which shows the growth in length of the normal and exposed tibiae of rabbits A-4, A-5 and A-6. Here, again, it is noted that rabbit A-4, which was first treated, shows a more marked effect than rabbits A-5 and A-6, in which the effects were almost the same. It would, therefore, seem probable that the differences observed might be attributable to the differences in dosage resulting either from the initial operation of the apparatus, or to the oft-repeated experience of finding that in the repeated application of a plan, error is most likely to occur with the first effort. Otherwise, it is necessary to assume that the same quantity of irradiation produces different effects in different individuals with the same hereditary and environmental conditions.

A comparison of growth curves in both normal and irradiated bones in all experiments shows conclusively that the inhibitory effect of the roentgen ray on bone growth is a change in rate of growth and not a change in duration of growth. No instance of complete cessation of growth in the irradiated bone before complete cessation of growth in the corresponding normal bone has been observed. This observation might be explained if it were assumed that the capacity for rate of growth in length of bones belonged to the bone alone and that the duration of growth was determined by influences arising elsewhere in the body. There is, however, another explanation which, although more fanciful, perhaps best fits with the results obtained in these experiments.

By comparing Figures 7 and 8, or best by studying the composite curves of Figure 9, it will be noted that the effect produced during the later period of growth is very nearly the same if the bone is exposed either at the age of twenty-one days or seventy-seven days. The curve "RO" is approximately parallel to the curve "SP." In other words, the effect of a certain amount of irradiation on the growth in length during any period is about the same regardless of the time before this period at which the exposure occurred. This is not only important from its clinical application, but it may have important significance in the consideration of the possible mechanism by which irradiation inhibits growth of bones.

Elongation of the shaft of a bone may be considered as periodic finite increments in length, as periodic proportional increments in length attained, and, finally, as periodic proportional attainment of its ultimate length. If a single influence of short duration produces a continuous effect throughout the entire period of growth, then it is best to study the effect of this influence from the viewpoint of total future length to be attained, or growth capacity.

If the capacity for growth of a bone lies within the bone, it must be assumed to be determined by some component of the bone which, for purposes of discussion, we may further assume

to be the cells of the epiphyseal cartilage. With this assumption, it follows that diminution in the capacity for growth might result from either of the following mechanisms:

1. The capacity for growth may be equally distributed between the cells and be dependent on the number of cells present. Destruction of any definite number of cells would thus proportionately diminish growth capacity.

2. Growth capacity might be diminished by a diminution in the capacity of each individual cell.

3. The cells may have varying degrees of growth capacity and different periods of existence. If such were the case, then the growth rate at any period would be a summation of the growth capacities of all existing cells. Furthermore, cells of different capacities for growth might have different degrees of vulnerability to roentgen rays. Destruction of cells of lesser growth capacities and longer life would diminish the rate of growth and shorten the period of growth. Destruction of cells with greater growth capacities and shorter life would diminish the rate of growth but would not shorten the period of growth.

The last of these methods, fanciful as it may seem, conforms best to the results obtained in these experiments.

Since connective tissue cells so easily reproduce themselves, and because the roentgen ray apparently has little or no influence on bone regeneration, it is difficult to assume that the inhibitory influence of the roentgen ray on bone growth could be brought about by destruction of cells only peculiarly vulnerable because of being in a particular phase of cell division. Furthermore, if growth inhibition were produced in this way, it would seem as if there should be some evidences of recovery.

Our knowledge at the present time of the vital characteristics of a cell is not sufficient for a discussion of the possibilities of producing in the cell changes which would be constantly reproduced in successive cell generations. Furthermore, it would seem as if a difference in the vulnerability of cells were

evident from the histological appearances of tissues which have been exposed to the roentgen ray. Some of the cells at least show no evidences of abnormality and others are obviously disintegrated.

Instead, therefore, of assuming that cells in the act of division are more susceptible to the destructive influence of the roentgen ray, we are assuming that cells with a capacity for rapid division are more susceptible than those with a capacity for slower division. It is obvious that this assumption is not contrary to the facts observed. Also it is not a distinction without a difference.

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PALLIATION IN ADVANCED MAMMARY CARCINOMA*

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IT is a sad commentary upon our contemporary civilization that so large a proportion of all carcinomas of the breast are far advanced when first seen by a doctor and that no hope can be had for more than palliation. This condition of affairs can best be remedied by a slow and persistent process of education, first of the profession and then of the laity, such as is being carried on by the American Society for Control of Cancer, The College of Surgeons, etc. This audience, of course, needs no such education but I wonder how many of you are doing your part to spread the doctrine of periodic health examinations and preventive medicine? It is just as much our duty to inform the layman and the physician of the early signs and symptoms of disease, especially cancer, as it is for us to treat these conditions after they have developed.

In considering a case of mammary carcinoma, especially a far advanced one, it is good to attempt to put oneself in the patient's place, and see what we would want done for us under similar circumstances. Fortunately all general surgeons are interested in diagnosing and treating early carcinomas of the breast; most surgeons are interested in the case of a well-developed, easily diagnosed mammary carcinoma; unfortunately many are prone to look with a sympathetic eye upon the poor patients with hopelessly advanced mammary carcinoma without much thought, and not even try to palliate their suffering since they seem so hopeless.

Just when a case becomes an "advanced one, for palliation only," varies with the group or individual consulted. Many institutions and surgeons place their limit of "primarily oper-

*From the Surgical Service of Steiner Cancer Clinic, Atlanta, Ga.

able cases" so low that their "advanced" cases would in other parts of the country (perhaps less educated) be considered relatively "early" ones. No definite criteria should be established. Each case should be considered on its merits after weighing the various factors mentioned below. In general, we consider as primarily inoperable those cases with distant metastases, those with involvement of supraclavicular nodes, those with large fixed nodes in the axilla, those with extensive skin involvement, those in which the location of the tumor renders technically difficult or impossible the complete removal of all the diseased tissues, those in which the general condition of the patient is such that a radical procedure cannot be carried out, those in which the growth is very cellular, etc. That is to say, so far as entertaining any hope of a permanent "cure" is concerned, they are inoperable. There are exceptions in each instance and frequently we accomplish much more while carrying out a supposedly "palliative" procedure than we ever dared hope or dream could be done. Those of us at Steiner Clinic have often, at our regular Wednesday conferences, heard our late lamented staff member and Fellow of this Association, Charles Dowman, tell of his patient with mammary carcinoma who had involvement of both the axillary and supraclavicular nodes. In spite of the apparently hopeless condition he did a radical operation, with "wide" dissection, and she is still living more than eighteen years since the operation. She had small recurrences removed fifteen years and seventeen years postoperative and now has two small ones. In the short life of our Clinic we have many patients who under any of the various standards of operability would have been classed as "primarily inoperable," who have passed their fifth postoperative anniversary.

It is far easier to determine the procedure to be carried out in an early case, than in an advanced one. There may be disagreements as to whether preoperative or postoperative radiation should be used, whether interstitial radiation should be employed, whether any surgical procedure should follow

any or all these types of irradiation; but everyone is agreed that some adequate treatment should be instituted and at the earliest possible moment. In an advanced case, however, a too zealously guarded professional reputation, or statistical data, or surgical timidity may cause us to adopt a watchful waiting policy when, as a matter of fact, the poor patient might be rendered more comfortable. Some relative or friend should be advised that there is no hope for a cure, but that the measures to be undertaken are merely in an attempt to make their loved one more comfortable and perhaps prolong life somewhat. This precaution should be taken to keep surgery from being brought into disrepute. If it is not and there is an early recurrence and death, the operation will be given credit for hastening the demise. It is with a hope of stimulating more thoughtful consideration of these depressing and even repulsive cases, and because few, if any, men are privileged to see in their private practice such a variety of cases as are here presented (from the Surgical Service of Steiner Cancer Clinic, Atlanta) that this report is presented. We would not give the impression that one case proves that all will behave in like manner, any more than that one swallow makes a summer, but have selected those typifying each class or group of cases.

What are the chief objects of "palliation"? In general, the comfort of the patient. As a rule the two things which cause most discomfort are pain, and the disagreeable odor attendant upon a sloughing mass. It is only when we can hope to lessen the pain, or prevent, delay, or reduce the slough that we are justified in attempting palliation.

Each case should be carefully considered as to:

(a) The probable duration of life
(b) Whether or not a slough is imminent
(c) Whether or not an immediate recurrence is likely
(d) The radiation-sensitivity of the tumor
(e) The general condition of the patient.

Each of these factors should enter into the decision of what to do in every instance. Of these, the life expectancy is probably

the most important. No definite line of demarcation can be drawn. They overlap and one factor will influence another. A radiation-sensitive tumor, for instance, is a highly malignant and very cellular one, and its progress will be rapid. This, therefore, influences the probable duration of life. Again the age is important. The same procedure would not be recommended for an octogenarian as for a woman in her fourth decade. If the patient apparently will not live but a few months with or without an operation, no surgical procedure should be advised.

A sloughing mass, especially in a large fat breast, should, whenever possible, be avoided. A large growth deep in the breast tissue is much less likely to ulcerate than is a smaller one near the surface. A sclerosing mass will not be as objectionable from this point of view as would be an expanding one. Not infrequently one will see a breast that has practically disappeared, from the carcinoma alone, and without ulceration or surgery.

The presence of a sloughing lesion is not always a contraindication to operation (Case x) nor is one in which an early recurrence seems likely. It again depends upon the size, location, character, etc., of the growth. It is a matter of personal opinion. If the slough is large and odor very disagreeable no harm will be done in performing a simple mastectomy, and the recurrence will not break down for many, many months. If, on the other hand, it is so large or so located that it cannot be completely removed without leaving a raw area to be skin grafted, the patient will probably be less uncomfortable if left alone.

The radiation-sensitivity may be determined by biopsy or by response to radiation. In such cases one is rarely justified in making a biopsy even with a punch, or needle, unless it is done preliminary to operation or at the time of introducing interstitial radiation. In a doubtful case one might excise a tumor mass from a breast, but in an "advanced" case this procedure is not justifiable. A fungating, sloughing tumor, or a wound which refuses to heal, not infrequently follows a biopsy. To

determine the radiation-sensitivity of a tumor, therefore, we give a cycle of high voltage *x*-ray treatments. If the response is marked and rapid this is followed by interstitial irradiation.

For the purposes of this discussion, I have arbitrarily considered these cases under the following classes:

1. Those in which nothing of benefit can be done, except to administer narcotics.
2. The "inflammatory" type.
3. Those in which the primary tumors are operable, but which have distant metastases, especially in the bones and lungs.
4. Those best treated by irradiation.
5. Those best treated by palliative operations.

1. CASES WHICH CANNOT BE BENEFITED

In the first group we have the cases which because of the extensive involvement, either of the primary tumor or of a recurrent growth, are inoperable from a technical standpoint. In other words, those in which it would be impossible to remove all of the diseased tissues without leaving a sloughing area, or in which an immediate recurrence would be expected. These are also usually extremely fibrous and resistant to radiation, but may and probably will receive *x*-ray treatments because of the beneficial psychic effects.

CASE 1. Mrs. J. L., widow, aged fifty-nine, admitted June 19, 1929. A lump was noticed in the breast in August, 1928. Radical mastectomy done in 1929 (not at Steiner Clinic). The incision did not heal. On admission she had a solid fungating nodule firmly attached to the underlying tissues at the inner end of the scar near the middle of the chest, which was about 3 × 2 cm. She was a morphine habitué, taking 10 grains daily. In spite of four cycles of *x*-ray treatments her condition has progressed rapidly, and she now has several foul-smelling ulcerating areas and the other breast is involved.

Pathological report: Carcinoma; the large lymph channels would seem to indicate an early and marked extension via these channels.

In this case surgery was obviously out of the question, and irradiation had very little lasting effect. All that could be done was to continue her morphine and increase the quantity as necessary.

2. THE INFLAMMATORY TYPE

In the second group we have the so-called erysipelatoid or "inflammatory" types of carcinomas which really do not constitute pathological entities but are merely different grades of extremely cellular, rapidly growing and infiltrating tumors, which because of their rapid growth usually present some of the cardinal signs of inflammation, local heat and redness of the skin especially, and hence their name. They usually present a diffuse involvement of the skin, with redness and "pigskinning," and do not always have a demonstrable tumor mass; they are late to metastasize to the regional nodes and the patients usually have a life expectancy of at most a year, or eighteen months, but live about six months longer with irradiation alone than they do following irradiation plus surgery, or surgery alone.

CASE II. Mrs. F. M. S., fifty-one years old, admitted July 11, 1931. She was said to have struck the breast with a piece of wood seven months previously. Two weeks later she noticed a non-tender lump in the breast "about the size of a hickory nut." This increased in size and other lumps appeared in the breast and axilla. Four months after the injury the whole breast enlarged and she is said to have been given ultraviolet treatments prior to her admission, and the breast is said to have increased in size somewhat. Soon the breast became painful and she used antiphlogistine and alcohol rubs.

On admission to the Clinic the breast was enlarged, and the skin was thick, dimpled and pitted on pressure. It was reddened, veins were prominent and the nipple was retracted. An indefinite mass was noted in the outer lower quadrant. Other masses were attached to the skin and deeper structures. There were several firm movable nodes in the axilla, no discharge from the nipple and no supraclavicular nodes.

No pathological report was obtained.

Two cycles of *x*-ray treatments were given (in July and September) and she returned to her home where she died February 13, 1932.

CASE III. Mrs. N. C., forty-nine years old, admitted January 10, 1929. She had noticed a lump in her breast for four months. She did not remember an injury to the breast. The lump is said to have been "the size of a hickory nut." It doubled in size, and on admission was 6×8 cm. The nipple was attached but the skin was otherwise not adherent. No glands were involved.

Three cycles of *x*-ray treatments were given in January, March and May, after each of which there was a definite regression in the size of the breast, but new nodes appeared. The patient grew progressively worse

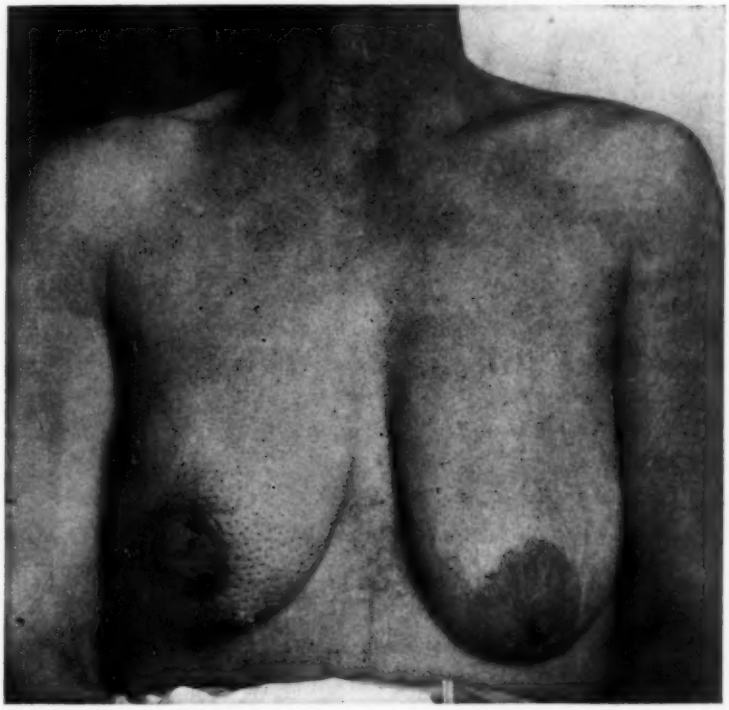

FIG. 1. Case III. January 10, 1929. Note extensive involvement of skin. No nodes palpable. Received *x*-ray treatments (four) January 16–23. Lesion progressed rapidly and patient died six months later.

and died July 29, 1929. No pathological report was obtained.

While no tissue was obtained from either of these cases they appeared clinically to be the so-called inflammatory type of carcinoma, especially the first one. The second did not at first show the usual signs of inflammation, but because of its rapid growth, and its quick but transient response to *x*-ray therapy, it was surely a very cellular, highly malignant tumor. Note particularly in Case II the history of having *rubbed* the breast. This accomplished no good, and probably hastened the progress of the disease. If surgical intervention had been attempted in either of these cases the patient would undoubtedly have been made more uncomfortable, and probably would not have

lived as long. Even the taking of a biopsy would have probably resulted in earlier ulceration.

3. PRIMARY TUMORS OPERABLE; DISTANT METASTASES

The third group is that in which the primary tumor is frequently small and relatively insignificant and may not even have been discovered, but in which are found metastases to distant points, especially to bones. These are very naturally "inoperable," and are treated only by irradiation, usually external.

CASE IV. Mrs. A. S., aged fifty-two, admitted February 15, 1926, complaining of pain in the bones, back and muscles for some time. She casually mentioned the fact that for the past few weeks the nipple of the right breast had been retracted and that she had had a hard mass in that breast for nine years which was 2 × 4 cm. X-rays revealed multiple generalized bone metastases. When she first came to the Clinic she could scarcely walk, and was so far advanced and hopeless that she was allowed to more or less direct her own treatments. She designated over what areas she should be treated each time and where possible this order was followed. She soon dispensed with her crutch and stick, and lived over three years, dying March 24, 1929.

CASE V. Mrs. M. D., aged thirty-seven, admitted October 24, 1927, complaining chiefly of inability to walk on the right leg. She had first noticed a tender place on the crest of the right ilium ten months before admission. This gradually grew worse and became very painful. There was no swelling or change in the color of the skin. Four months prior to admission her shoulder became affected. Then she noticed pain in the right hip. A severe cough followed, and this appeared to make the pain in the leg worse.

On admission films showed no evidence of metastases to the lungs, mediastinal nodes or skull. There was widespread involvement of pelvis, humeri and femora. She received numerous *x*-ray treatments. In June, 1929 films for the first time showed metastasis in the chest behind the eighth rib, but nowhere else. She died September 20, 1929.

In both of these cases the lesion in the breast played a very inconspicuous part in the history. In each case surgical removal could easily have been accomplished, but would have been not only unjustified but even, one might say, criminal. They

emphasize the necessity of making not only a preoperative *x*-ray study of the chest, but also one of all the long bones if there have been any symptoms relative to bones or joints.

FIG. 2. Case VI. September 10, 1931. *X*-ray treatments on September 11 and 15. Tumor regressed.

It is interesting to note that the first of these patients had noticed a hard lump in the breast for nine years, but thought nothing of it, and the second one did not mention her breast.

4. CASES BEST TREATED BY IRRADIATION

In the next group we find those best treated by irradiation either alone, or in conjunction with surgery later, and these cases may be divided into those which are inoperable because of technical difficulty in removing the growth and those which are inoperable because of the general condition of the patient.

CASE VI. L. N., negro woman, married, fifty years old, was admitted September 10, 1931, at which time she said she had first noticed a sore place on the left breast three or four months previously. It bled some, at different times, and gradually increased in size and tenderness. She said she felt no mass. She is said to have received four injections of aolan at

another clinic. On admission the left breast contained a large fungating, bleeding tumor 10 cm. in diameter and 5 cm. to 7 cm. thick. There was a node 2.5 cm. in diameter in the axilla, but freely movable.

FIG. 3. Case VIII. January 19, 1932. *X*-ray cycles in January and March. 2983 mc. hrs. radon in gold seed implanted April 15, 1932.

Following two *x*-ray treatments the tumor regressed. She was given four more *x*-ray treatments the following month and then gold tubes containing radon capable of rendering 2660 millicurie hours of radiation were inserted in the gland in the axilla, and enough in the breast to give 7497 mc. hrs. A swelling and dermatitis followed and the ulcer did not heal until two months later. It finally healed and the node regressed and the mass in the breast now is scarcely noticeable. There does not seem to be any "activity" in the breast at present.

Pathological report: Infected, partly degenerated (biopsy taken six weeks after *x*-ray) adenocarcinoma.

CASE VII. Miss A. McC., aged seventy-eight, admitted September 8, 1931. Two and a half years before admission she first noticed a lump in the upper part of the left breast, said to have been 2 cm. in diameter. It did not increase in size until six months ago, when it grew larger and was accompanied by pain.

On admission the mass was described as being 5 × 10 × 10 cm., nodular, purplish red in color, darker in some places than others. It involved the skin but was movable on the deeper structures. Due to the patient's age and general debilitated condition it was decided to rely on *x*-ray and radium therapy. She had two light therapy *x*-ray treatments and two months later 8184 mc. hours of radon implanted in gold tubes in the breast.

The lesion has regressed until now it is scarcely noticeable and there seems to be no activity.

CASE VIII. M. H., a colored widow, aged sixty-three, admitted January 19, 1932. She had borne thirteen children and had one miscarriage. Menopause occurred at fifty. She claims to have had pain about the left nipple about a month before admission. A day or two later she noticed a lump in the breast above the nipple. This became more painful. She poulticed it for about a week and then it ruptured and drained. Since then the breast above the nipple has become hard and there has been an enlarged node in the left axilla.

On admission the lateral half of the left breast was described as being involved by the mass, which was hard and infiltrated. There was an excavation 6 cm. in diameter and 2 to 3 cm. deep. The mass was fixed to the overlying skin and to deep structures. A node 3 cm. in diameter was noted in the left axilla, which was fixed. Following four *x*-ray treatments there was definite regression of the mass in the breast and the axillary node and ulcer were reduced in size. Two months later four more *x*-ray treatments were given and the following month gold tubes were inserted in the axilla and breast, representing respectively 2983 and 5860 mc. hours of irradiation. The ulcer is now practically healed, but there is a little pocket of pus which continues to drain. Two small recurrent nodules have recently been found in the skin over the breast.

Pathological report: Carcinoma.

All of these cases exemplify remarkable palliation following combined *x*-ray and interstitial irradiation. In the first, the *x*-ray treatments were given as a preliminary step to operation. The response was so prompt and noticeable that it was decided to give more *x*-ray and also some interstitial irradiation. The result was so pleasing and satisfactory that operation was then considered unnecessary. In the second, the breast could easily have been removed, but the patient was seventy-eight years old and her general condition did not warrant an operation. In the last, the location, the extent, and the fixation

of the tumor rendered it technically difficult, if not impossible, to remove the diseased tissues surgically.

5. CASES BEST TREATED BY PALLIATIVE OPERATIONS

In the last group are those cases in which it is obviously impossible to remove all the diseased tissue, but in which the patient may be relieved of a foul-smelling, sloughing mass by a palliative operation.

CASE IX. W. N., Negro man, aged sixty, was admitted on July 30, 1925, giving the history of apoplexy and of having suffered with heart disease for years. One year previously he had noticed a small nodule in the left breast. He had refused to have any surgery because of his heart disease. The lump had grown larger and on admission was described as being 5×7 cm. and irregular in contour. It was fluctuant over the most prominent portion and the skin was very thin, but the breast was freely movable over the chest wall. There were involved nodes in the left axilla. Because of his general condition nothing more was done than to remove the breast under local anesthesia.

Pathological report: Diffuse round cell carcinoma; embryonal carcinoma.

Following the operation he had nine cycles of *x*-ray treatments extending from September 7, 1925 to February 21, 1929. He died on May 4, 1929.

CASE X. P. W., a colored woman aged forty-seven, was admitted October 16, 1929, and claimed that she had not noticed a lump in the breast until eight months previously. This grew progressively and three months before admission it ulcerated. She had lost some weight. On admission the right breast was ulcerated in the lower portion and firmly fixed to the underlying structures. There were also axillary nodes. Chest films showed mediastinal involvement. The breast was painful. She was given *x*-ray treatments but three months later instead of having regressed the tumor and ulcer had about doubled in size. She was then advised to have a radical amputation, not with any hope of curing her, but simply to get rid of a foul-smelling, sloughing mass. She lived in comparative comfort for about two years without evidence of disease, then developed recurrent masses and died July 13, 1932.

Pathological report: Adenocarcinoma III.

CASE XI. Mrs. J. M. H., aged forty-three, admitted November 11, 1929. She had had a hard non-tender, non-painful lump in the upper left breast for four years. It had slowly increased in size. About one year previously the skin over the lump had become red, and sometime during the past year "tight clothing" had caused it to ulcerate. On admission

the lesion was described as being in the upper outer quadrant of the left breast, 5 × 7 cm. in size, ulcerated, red, with the skin fixed over it, and the lesion itself adherent to the underlying muscle but not apparently to the

FIG. 4. Case X. January 20, 1930. Note remarkable progress in spite of *x*-ray treatments.

chest wall.

A radical mastectomy was performed on November 19, 1929 as a palliative procedure. At operation the mass was found to involve the intercostal muscle. Some gold seeds were implanted in this area.

Pathological report: Scirrhous carcinoma with probable involvement of the pectoral muscle. No axillary metastases found.

Three months later a supraclavicular node was noted. It regressed under *x*-ray treatments.

Twenty-one months after operation a nodule was noted in the skin over the right breast and also a node 3 cm. in diameter in the *right* axilla. After preoperative irradiation a radical mastectomy was done on the right side on September 10, 1931. Part of the subclavian vein was resected but even then all the diseased tissue could not be removed.

Pathological report: Scirrhous carcinoma with axillary metastases, radiation-resistant.

In May, 1932 (thirty months postoperative) the patient complained of a cough. X-ray examination was reported as showing pleural effusion and probable pleural metastases. There was also a nodule in the skin in

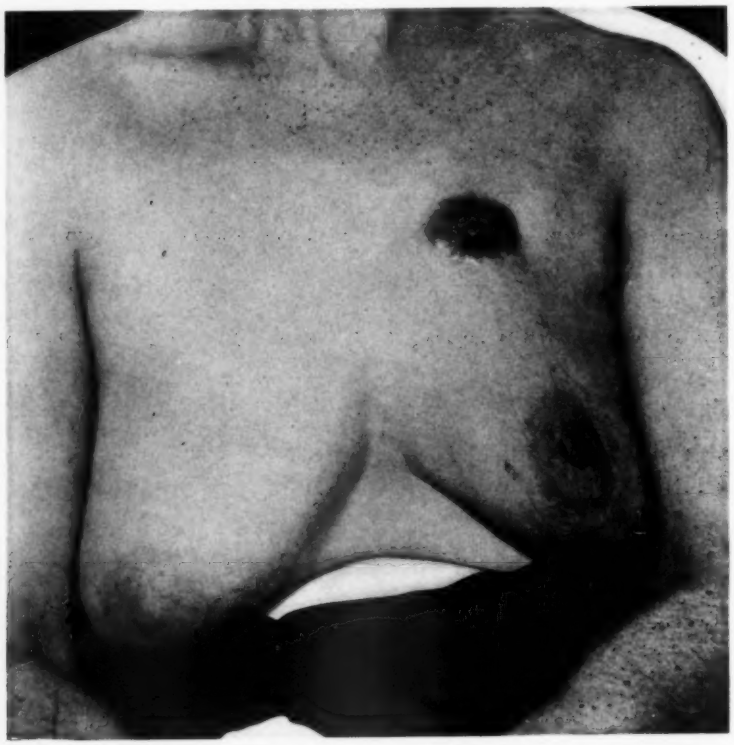

FIG. 5. Case XI. November 11, 1929. Note growth in upper part of breast; ulcerated; fixed to muscles.

the left axilla, two suspicious nodules near the site of the original tumor, and a supraclavicular node on the right side 1.5 cm. in diameter. More *x*-ray treatments were given and paracentesis thoracis performed.

In June, 1932 (thirty-two months postoperative) *x*-rays showed involvement of the fifth lumbar vertebra. She became progressively and rapidly weaker and died November 15, 1932.

These offer no incentive to the timid surgeon nor to the one carefully safeguarding his breast operation statistics or professional reputation. One must have the patient's comfort in mind rather than the preservation of favorable statistical tables. The family of the patient should understand clearly that no hope of a "cure" is entertained, but that we are merely attempting to make her last days more comfortable. Occa-

sionally striking results are obtained; in the three cases here illustrated the patients lived four, two and one-half, and three years respectively, and in comparative comfort and the last showed practically no evidence of local recurrence. In one case in which no good illustration is available, it was necessary to even cut through malignant tissues, but the patient is still alive and active more than six years after the operation.

Cordotomy, recently advocated for the relief of pain in hopeless cancers, rarely, if ever, will have to be resorted to in mammary carcinomas, unless the pain is from some distant metastases. The pain in these cases can usually be controlled with opiates.

SUMMARY

Consider carefully and thoughtfully each case of advanced mammary carcinoma on its merits. Every case is entitled to *some* treatment if only for the psychic effect.

Factors to be considered:

(a) The probable duration of life.

(b) Whether or not a slough is imminent.

(c) Whether or not an immediate recurrence is likely.

(d) The radiation-sensitivity of the tumor.

(e) The general condition of the patient.

Cases arbitrarily divided into the following classes or groups:

1. Those in which nothing of benefit can be done, except to administer narcotics.

2. The "inflammatory" type.

3. Those in which the primary tumors are operable, but which have distant metastases, especially in the bones and lungs.

4. Those best treated by irradiation.

5. Those best treated by palliative operations.

COMMENT

When permanent eradication of the disease seems impossible, palliation should be attempted. Harm can come only to

the professional record and reputation of the surgeon. Life holds but little for the patient, and the more advanced the disease is the less pleasure is left. In performing palliative operations in apparently hopeless cases, much unexpected good is often accomplished. Put yourself in the patient's place, and imagine what *you* would want done to you under similar circumstances.

DISCUSSION ON PAPERS OF DR. LEE AND DR. NICOLSON*

DR. LOUIS FRANK, Louisville, Ky.: I hesitate to compare my experience with the extensive experience of the gentlemen who have read these papers. I think there are many things in connection with cancer which should interest surgeons in addition to the special problems associated with cancer of the breast. We are again impressed with the age incidence of carcinoma. As Dr. Cullen said at White Sulphur, we are again struck with the fact that carcinoma is not a terminal disease as is cardiorenal disease but a terminating disease. The average age incidence is thirty-five to fifty in our experience, not only with cancer of the breast but of the cervix uteri.

I think we should make a distinction between local recurrences or recurrences in the lymphatics which are located near the primary seat of the carcinoma and the distant metastases, whether early or late. I am not at all hopeless of the outcome in the cases where there are local recurrences. We have in several instances removed local recurrences, treated the patient with radiation, and some of them have gone now as long as eight or nine years following this treatment.

I think it is very important that every patient with carcinoma of the breast should be studied carefully for distant metastases before any operation is undertaken. Many cases will show distant metastases, particularly in the bone, if this is done. The cases in which early metastatic death ensues following operation mean that we have overlooked secondary cancer foci which existed at the time of operation. I am of the opinion that these foci are present in all cases in which secondary bone or other distant cancer occurs, the disease not having reached such an extent in development as to be recognized.

We no longer practice preoperative radiation in cancer of the breast but we do irradiate all cases postoperatively. Formerly we left the wound wide open, beginning radiation within a few days postoperative and closing the wound subsequently. Now since we have the high voltage current we close our wounds primarily but irradiate them all postoperatively, using the technique of the Memorial Hospital. We have not treated any cases by

*Dr. Lee's paper appeared in the May issue of THE JOURNAL, p. 405.

postoperative radium implantation. In about 400 cases of breast cancer with radical removal we have lost only one patient, and I think if the cases are carefully studied preoperatively there is no reason for operative deaths in cancer of the breast. The patient we lost died of uremia, the others have all recovered promptly.

I think our small clinic may have afforded a better opportunity of giving personal attention and following up the cases, and that this personal attention has given us results that compare favorably with those reported this morning. These patients should be followed over many years. One of our patients had a local recurrence two or three years after operation but under irradiation is still alive after about seven years. We had one patient with apparent involvement of the lung and of the spine which disappeared under deep roentgen therapy, and it has now been about eight and a half years since the primary operation.

Dr. H. B. Gessner, New Orleans, La.: Will Dr. Lee tell us what stress he lays on the radio knife?

Dr. A. C. Scott, Jr., Temple, Tex.: We have felt in our clinic that the great question in the cure of cancer of the breast, and the only hope for further improvement of surgical technique, is the elimination of local recurrences. If patients have distant metastases beyond the axilla there is no hope of surgery doing any good. In connection with distant metastases, we have noticed that one of the earliest signs is pain, simulating neuritis, particularly in the back, hips or legs. Careful histories with regard to neuritic type of pain, and complete *x*-ray studies in such cases will often reveal metastases in various bones or in the chest.

We believe the majority of local recurrences can be eliminated by the use of the cautery knife. As many of you know, my father in 1914 started using the cautery knife for gland dissections, and we think the better results we have obtained come from the use of this cautery knife.

We have only a small series of five-year cases. Prior to 1926 only 86 patients considered to have an operable condition were operated on. In addition to this there was a group of 19 patients who had inoperable conditions that were operated on for palliative purposes. In this group of 19 inoperable patients, 3 were alive and well at the end of five years. In reporting the series in 1931 before the Segunda Convencion Medica del Noreste de Mexico, I found that of the 86 operable patients, 68 were alive five years or longer.

The increased percentage of good end results is proportional to the reduction in the percentage of local recurrences and we believe is due to the elimination of local recurrences by the use of the cautery knife.

Dr. Burton J. Lee (*Closing*): The points made by Dr. Frank are important. Unless the cases are carefully surveyed and a complete history

obtained there is no question but many breasts are radically operated upon that should not be so treated. I was visiting a clinic recently in New York where a radical amputation was in progress; the chest plate was brought in, revealing extensive chest metastasis.

As to the cautery knife, we have not used it nor have we been enthusiastic about it. As we have followed our cases treated by knife resection, we have felt that our percentage of recurrence was no higher than where cautery dissection had been done. Our percentage of local recurrence in all cases is 12 per cent. We still feel that by knife dissection, if the dissection is carried down to the rib margin with removal of a wide area of fascia, that local recurrence will seldom occur.

We believe it is better to have a closed wound, although this opinion is not in accord with the opinion of some other surgeons. If the tumor is so placed that the wound cannot be closed without undue tension, then skin grafting should be carried out.

I congratulate Dr. Frank on his low mortality, which I consider extraordinary. Local recurrences may appear a long time after radical amputation, the longest interval I have encountered being thirty-eight years. We had one patient whose husband had read about daily exercises, and began to do hand springs around the bedroom, morning and night. Then the wife decided to follow his example. She was rather heavy and fell, and while attempting to stand upon her hands felt a sudden pain in the axilla of the operated side. Three weeks later a definite supraclavicular fullness had developed and some sizable supraclavicular nodes were palpable. The disease progressed rapidly, the arm became swollen, and she died four months later. The work of Lewis and Niehoff showed how important it is to follow these cases over many years.

I am gratified that Dr. Frank and Dr. Scott have struck an optimistic note on cancer of the breast, for often laymen feel absolutely hopeless and, unfortunately, we find many doctors who think that the treatment of mammary cancer is a losing game from the outset. We must be optimistic if we are going to achieve anything like satisfactory results in the treatment of this disease.

RECURRENT ECTOPIC PREGNANCY

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ROANOKE, VA.

THE admission to Jefferson Hospital, Roanoke, Virginia, of 2 cases of repeated ruptured tubal pregnancy within a week, called my attention to this comparatively unusual condition, and consequently to a consideration of the type and extent of the previous operation.

It is universally accepted that operative removal of the involved tube is the treatment of choice, but what should be done with the other tube?

A review of our 89 cases of tubal pregnancy revealed an additional instance of recurrence thus giving a percentage in this series of 3.3.

It was found that in 13 of the 89 cases, removal of both tubes or hysterectomy had been done because of gross inflammatory disease, or in one case, myomata of the uterus, thus limiting the number of patients who were capable of subsequent pregnancy to 76.

A questionnaire was sent to all of these 76 patients as follows:

1. Have you had any pregnancies since your operation?

2. Have you had any trouble similar to that for which you were originally operated upon?

Of the 76, replies were received from 36, not quite one half, but, of this rather small number, it was found that 12 women had been delivered of 23 normal children, and 3 had had miscarriages. It is evident, therefore, that 33⅓ per cent of the patients traced were capable of having normal children after their operation for tubal pregnancy.

These figures are slightly lower than those of some other observers.

Giles[1] reported 12.8 per cent repeated ectopics in 39 patients, while 34 per cent of these had subsequent normal pregnancies.

Essen-Moller[2] reported 5.1 per cent of 39 cases repeating with 46 per cent having normal pregnancies.

R. R. Smith[3] found 13.8 per cent repeating in 144 patients while 32.6 per cent of these later had normal children.

Smith also collected from the literature approximately 4 per cent repeated ectopics in 1390 cases, with 36 per cent of these patients later having normal pregnancies.

In 1912 Dr. Stuart McGuire[4] read a paper before this Society reporting 5 cases of repeated tubal pregnancy in a series of 35. Six or 17.7 per cent of these patients bore normal children after their primary operation for tubal pregnancy.

The most recent report to come to my notice is that of H. L. Murray,[7] who found 6 or 4.1 per cent repeated tubal pregnancies in 146 cases.

It is seen, therefore, that the condition is no great rarity after all, and the possibility of recurrence must be considered whenever we operate on a patient with tubal pregnancy.

Our knowledge of the causes of ectopic pregnancy is none too complete. It seems obvious that there must be some obstruction to the passage of the fertilized ovum through the tube, but it is very rarely possible to demonstrate any gross lesion which could account for this obstruction.

Extensive pelvic inflammatory disease, previous attacks of appendicitis, ovarian cysts, myomata, accessory ostia or diverticula of the tube have all been suggested as possible causes, but can seldom be demonstrated.

C. D. Williams[5] in 1908 reported the results of several years' study of tubes removed from patients operated upon for ectopic pregnancy, and also observations of the opposite tube removed at the same time. He states that in every case he found evidence of a pre-existing inflammatory process involving the mucosa, not only of the tube in which the pregnancy was found, but also of the opposite tube. This inflammation of the mucosa, he believes, causes adhesions of the mucous folds to each other, and so produces false diverticula in which the impregnated ovum may become pocketed.

He also calls attention to the familiar fact that salpingitis, whether gonorrheal or puerperal in origin, is usually bilateral.

Whatever the cause of tubal pregnancy may be, however, and granting that a woman who has had a pregnancy in one tube may be a candidate for a similar occurrence in the remaining tube, the significant fact remains that a large percentage of these women are still capable of bearing normal children.

The question naturally resolves itself, then, into a consideration of the individual case, each on its own merits.

The elements of the patient's age, her general condition, the number of living children and possibly the social status must all be given due weight.

In many cases the patient's condition has been rendered so precarious by intra-abdominal hemorrhage, that simple removal of the involved tube is the only justifiable procedure.

This conclusion is in accord with the opinion expressed by the various authors who have reported similar cases, with one exception, and this exception is rather interesting.

Sserebroff[6] of Leningrad reports 16.5 per cent of 97 cases repeating and advocates removal of both tubes at the same time, an opinion in keeping with the spirit of radicalism so characteristic of present-day Russia.

SUMMARY

1. Three cases of repeated tubal pregnancy are reported.

2. The percentage of normal pregnancies following a tubal pregnancy is much greater than the percentage of repeated tubal pregnancies.

3. The opinion is expressed that in the absence of gross disease of the uninvolved tube, it should not be removed.

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DISCUSSION

Dr. W. F. Shallenberger, Atlanta, Ga.: I think the idea of removing both tubes because a patient has had a tubal pregnancy on one side is extremely radical and inexcusable. There would be the same indication to remove both ovaries because the patient had had a cyst in one ovary. I have never seen but one patient who had a tubal pregnancy on the opposite side after having a pregnancy in one tube. In one instance I saw a patient just a year to the day after she had had a tubal pregnancy on one side and had to operate for a pregnancy on the opposite side. In one patient who consulted me because of sterility and for whom I did a tubal insufflation, a pregnancy in one of the tubes occurred which necessitated operation. Since then she has been delivered of two normal children. I think that excision of both tubes because of the possibility of tubal pregnancy occurring again on the opposite side would be indefensible in the majority of instances.

Dr. John A. Martin, Montgomery, Ala.: I wish to ask Dr. Jones if he has any information about the time between the recurrence of the pregnancies. For about six years I did not see any ectopic pregnancies, and then I saw one each month for five months. In November of last year I operated on a patient with a ruptured ectopic pregnancy of about three weeks. In February the same patient had a pregnancy on the opposite side which also ruptured and went on for about three weeks. I was under the impression that the second rupture was due to a large clot in the cul-de-sac which involved the other tissues. It was impossible to tell exactly the condition of the opposite tube at the time of the first operation and I thought the adhesions might have had something to do with the ensuing tubal pregnancy. In December I saw a patient who had had two abdominal operations. The tube appeared normal except where the ovum was attached near the fimbriated end. I thought perhaps she had some inflammatory reaction at the time of the other operation because of the conditions present.

My interest in knowing the exact time is to see if the rupture and adhesions have anything to do with the condition of the tube on the other side.

Dr. B. C. Willis, Rocky Mount, N. C.: In reporting a series of something over 100 ectopic pregnancies, operated upon at Park View Hospital, we have found this condition three times as common in the colored as in

the white race, and we all know that inflammatory conditions are much more common in the colored. We feel that previous infections do account for a large percentage of these extra-uterine pregnancies.

I was interested in what Dr. Jones said about not removing a good tube. We have adopted a rule to ask these patients whether they have children and whether they desire further pregnancies, explaining to them the possibility of a similar occurrence in the other tube. We are then guided by their wishes as to removing the remaining tube.

Dr. Alfred P. Jones (*Closing*): In answer to Dr. Martin's question, one of these patients repeated in almost exactly one year after the first ectopic pregnancy and the other in eighteen months. The interval in the third I do not recall. There was no evidence of an inflammatory process which could be blamed for the repeated ectopic pregnancy.

As to the remarks of Dr. Willis, these were all white women. In the colored race there is not only a greater incidence of inflammatory disease but they also are a very prolific race.

CHORIOEPITHELIOMA OF THE UTERUS

WM. T. BLACK, M.D., F.A.C.S.

MEMPHIS, TENN.

CHORIOEPITHELIOMA of the uterus, while a comparatively rare disease, is probably the most dreaded of all post-pregnancy complications. Undoubtedly it occurs oftener than suspected and is the cause of many undiagnosed deaths, such deaths being attributed to sepsis and anemia. Saenger, in 1888, was the first to describe the diagnostic symptoms. Gottschalk first advanced its fetal origin, which was concurred in by Frankel and Durante, but it was left to Marchand, in 1895, to recognize that the syncytial and Langhan's cells from the chorionic villi were histologically responsible.

Undue proliferation and infiltration of anaplastic and dissociated syncytial and Langhans' cells, characterized clinically by uterine bleeding and metastasis, is known as chorioepithelioma.

Ewing, in 1910, gave his comprehensive investigations on the prognosis from a histological study and classified the condition as occurring according to his histological findings as chorioadenoma destruens, syncytial endometritis and typical choriocarcinoma (chorioepithelioma).

Novak's classification, of either benign or malignant types, seems more acceptable, yet from a histological study there are atypical cases of malignancy which complicate the situation.

Chorioepithelioma is a rare growth, which is verified by workers in some of the larger clinics, viz.: In Budapest there have been no cases reported; Synes states that "only one chorioepithelioma was found in 8000 autopsies and 35,000 operations, at the Bellevue Hospital, in the past eleven years"; Douglass states that "in 5000 pregnancies nc chorio-

epitheliomas were found." Statistics from other large institutions verify the rarity of the condition.

This malignant growth occurs during the fertile age of the female and the more fertile the individual the greater the chances for its development. Teacher says that, "The highest peak is at thirty-three years of age, and the older the woman, the greater the chances of malignancy." The statistics of Pollasson and Violet, Teacher, Hitschmann and Christofoletti, Ladinski and Williams, show that about 45.7 per cent of chorioepithelioma develop from hydatidiform moles, while next in frequency is abortion, 30.4 per cent; labor, 23.4 per cent; and ectopic pregnancy, 3.4 per cent. Improper inspection of the products of conception accounts for many partial mole formations being undiagnosed, therefore, chorioepithelioma probably occurs in less than 1 per cent following moles, as stated by Meyer, Novak and others.

In 76,077 pregnancies by various observers hydatidiform mole occurred 80 times, or one mole in 950 pregnancies. In the past 20,493 pregnancies in Memphis there was an occurrence of 16 moles, or one mole in 1280 pregnancies. There have been diagnosed 6 cases of chorioepithelioma, or an occurrence of one in 3415 pregnancies. Only one of these 6 cases followed a mole (Case I). One followed labor (Case V). Four followed abortions (Cases II, III, IV, and VI). The latter report does not coincide with the accepted idea that they more often follow moles than other forms of pregnancy, but the number cited here is too small to draw conclusions.

Just why trophoblastic tissue pursues a malignant course in some and a benign course in others is not understood. It is known that some lytic substance in the maternal blood offers a resistance in normal pregnancy to the invasiveness of chorionic tissue. This is evidenced by the formation of Nitabush's membrane and by the destruction of syncytial and Langhans' cells, which are at times found during normal pregnancy invading the uterine wall and at times found in the liver, lungs and other organs.

Blair Bell thinks that after the death of the fetus normal restraint is lost in the individual; consequently the epithelial cells are allowed to grow in a lawless manner. Frankel states that "in chorio-epithelioma this lytic substance is lost." Erhlich taught that during pregnancy the organism develops antibodies (cytolysins) against strange cells and their products. These lysins destroy, according to Veit, Poten and others, these migratory chorionic cells, which are found during normal pregnancy. Kaufman states that "these cells disappear usually in eight days after delivery, but may remain weeks and if they continue to grow malignancy may occur."

The absence of these restraining syncytiolytic properties probably accounts for the ability of these chorionic cells to invade and metastasize as a malignant growth. For some unknown reason this lytic substance may be acquired and be responsible for regression, which at times characterizes these neoplasms.

It is not unreasonable to believe that after removal of the parent growth in the uterus the individual has an opportunity of developing this lytic substance, which accounts for the metastases regressing. In these neoplastic growths the development of theca lutein cysts of the ovary is often found, due no doubt to the excessive amount of anterior pituitary hormone. These cysts recede after the removal of moles or chorionic structures.

Ewing says: "There should be no difficulty in diagnosing a malignant from a benign mole." However, in those atypical cases, while the mole is undergoing a malignant transformation, the diagnosis is difficult. A history of pregnancy followed by a uterine bleeding, especially after a curettage, with microscopic findings of anaplastic and disorderly arrangement of cells and metastases is confirmatory of chorioepithelioma.

Schmidt states: "A diagnosis may be made when solid masses of syncytial and Langhans' cells are found side by side with destruction of uterine tissues, invasion and erosion of blood vessels and the presence of extensive necrotic masses

with rapid proliferation of the tumor cells." "Bands and masses of acidophile syncytial cells commingled in disorderly relations with islands of Langhans' cells are diagnostic" (Schmorl).

There is an absence of mesodermic connective tissue stroma and blood vessels in the typical chorioepithelioma, the growth receiving its blood supply parasitically. The gross pathology is characterized by invasion and permeation of uterine tissue and sinuses and at times perforating through the uterine wall into the peritoneal cavity.

Metastasis to the lung with erosion of the blood vessels is common. Metastasis to the vagina, cerebrum, kidney, liver and other organs often occurs. The uterus in some cases enlarges rapidly, becoming soft and irregular in size; especially is this true in chorioadenoma. However, in the most malignant types the uterus often remains small, having extensive invasion only at the placental site. The tissue is friable, brownish or bluish gray in appearance, depending upon the amount and age of the hemorrhage and necrosis.

If a patient has uterine bleeding, either menorrhagia or metrorrhagia following a recent pregnancy, one should be suspicious of retained products of conception. The bleeding will be particularly suspicious if it follows a mole. It is not uncommon to have a foul leucorrheal discharge, tinged with blood. One may be able to palpate a nodule on the external surface of the uterus, or in the adnexae. At times hemoptysis may be the first symptom to attract attention.

Metastases to the vagina, or hemorrhage from the kidney, or cerebral symptoms with rapid emaciation and anemia may be present, directing one's attention to the pathology. Recurrence of hemorrhage after a curettage is almost pathognomonic, following a pregnancy, especially a mole.

These symptoms with the histological findings previously enumerated will confirm the diagnosis of chorioepithelioma. It a patient gives a history of bleeding following any form of pregnancy, an Aschheim-Zondek test should be made to find out if there remains any biological relationship between the

mother and the products of conception. If a positive report is obtained, then a careful diagnostic curettage should be performed to determine whether the condition is one of benignancy or malignancy. If the patient continues to bleed after the curettage, another Aschheim-Zondek test should be made to determine whether all of the fetal structures have been removed. If the test continues positive and the first curettement did not reveal sufficient proof of malignancy and the bleeding continues, a second curettage should be performed. A hysterotomy may rarely be necessary for diagnostic confirmation.

The findings of syncytial and Langhans' cells, unless in large numbers and in an anaplastic and disorderly arrangement, is not sufficient evidence to justify a diagnosis of chorioepithelioma.

The writer was recently consulted regarding a patient, who four months previously was delivered of a normal child; four months later a severe uterine hemorrhage occurred. The uterus enlarged rapidly and a mole was passed. She was curetted twice in three months due to positive Aschheim-Zondek tests and suspicious histological findings. However, the clinical symptom of bleeding was absent (some discharge). The Aschheim-Zondek test continued positive for four months, then became negative without development of symptoms. A hysterectomy was considered expedient until a negative test was reported.

This case confirms that clinical manifestations should also be present to assure the diagnosis.

Aschheim states that "a pregnancy reaction in mice is twelve times stronger in a mole and chorioepithelioma than in a two months gestation." The time limit for elimination of hormones in this condition is not known.

If Ewing is correct, regression only follows incomplete removal in atypical chorioepithelioma; however, in Lackner and Leventhal's typical case recovery occurred. Malignant choriomas following moles are more favorable than malignancy after normal pregnancies. It is believed by some that chorioadenoma follows a mole, while chorioepithelioma follows an abortion, labor, ectopic pregnancy and retained placenta.

The treatment consists of prophylactic measures and the treatment of the neoplasms. Prophylaxis consists in an early curettage after pregnancy with a positive Aschheim-Zondek test, and uterine hemorrhage; particularly is this true following a hydatidiform mole.

The writer does not believe hysterectomy or irradiation advisable following moles, from his observation of cases observed over a period of years. The patient in Case 1 is the only one who developed chorioepithelioma following a mole.

The treatment for chorioepithelioma is a panhysterectomy followed by irradiation. If the case is inoperable, and a very poor surgical risk, radium and *x*-ray should be employed. Hysterectomy or irradiation as advocated by some for prophylactic measures after moles will prevent malignancy, but the occurrence of malignancy is so rare (possibly 1 per cent) that a sacrifice of the physiological functions of the young woman is not justifiable. In a patient during the menopausal age, when malignancy is more apt to occur, one may be wise to consider such radical treatment. In a recent patient, a woman fifty-two years of age, with a mole, marked prolapse and a complete laceration, the writer performed a complete hysterectomy.

The condemnation of the curette following mole is unjustifiable. If one uses a large dull curette (scoop) with gentleness and care, I do not believe it more dangerous than to deliver the mole manually. A great deal, of course, depends upon the dilatability and size of the uterus. In most cases a more thorough removal of the mole can be accomplished with the curette. Radium followed by deep *x*-ray therapy is adequate; however, in the presence of infection, or in a large uterus with profuse bleeding, radium is contraindicated.

If malignant changes are permitted to occur, due to the absence of some hormone or lytic substance in the mother's blood after destruction of the fetus, then theoretically the giving of hormones or the blood of a pregnant woman would

be indicated as a prophylactic as well as a curative agent in the treatment of chorioepithelioma.

The following 6 cases have been reported by competent pathologists as being chorioepitheliomas. Photographs and figures allude only to Case 1.

CASE 1. Mrs. P., aged twenty, with 1 child, three years old, entered the gynecological service of Baptist Hospital, January 21, 1932. Family history was negative. Menstruation began at twelve years, was of the twenty-eight day type, of five days' duration, there was moderate dysmenorrhea, she passed clots. She had a miscarriage October 28, 1930. She passed a mole March 25, 1931; bled two months before passing the mole, after which she continued to bleed until May 10, 1931, when she was curetted. Bleeding ceased for two weeks. She gradually became worse until November 11, 1931, when a second curettement was performed. She remained well for one month, when she commenced to bleed and was curetted the third time, in December, and again, January 8, 1932. This last curettement was followed by a foul-smelling discharge and the patient had a septic temperature upon entrance to the hospital.

Examination revealed the generative organs anemic, a relaxed perineum, vagina negative, cervix negative, uterus slightly enlarged, soft and retroverted, appendages negative.

The temperature subsided on January 26, 1932 and continued normal with a dropping pulse, but the patient commenced to bleed. After a positive Aschheim-Zondek test she was curetted the fifth time (February 4, 1932). The pathologist, Dr. Leake, reported from the uterine scrapings, chorioepithelioma.

Blood examination January 21, 1932: hemoglobin 50 per cent; red cells 2,780,000; white cells 13,900; small lymphocytes 15 per cent; polymorphonuclears 85 per cent. Sedimentation time, fifteen min. Wassermann reaction negative. After blood transfusion, January 25, 1932, hemoglobin was 58 per cent; red cells 3,310,000. Another transfusion was given on January 29, 1932 and hemoglobin was 40 per cent; red cells 3,350,000; white cells 8000; small lymphocytes 24 per cent; large lymphocytes 1 per cent; polymorphonuclears 75 per cent, sedimentation time eighty min. She commenced to bleed. On February 12, 1932, the blood showed hemoglobin 40 per cent; red cells 2,030,000; white cells 9350; small lymphocytes 16 per cent; polymorphonuclears 84 per cent. (Blood transfusion.) February 14, 1932, hemoglobin 54 per cent; red cells 2,900,000; microblasts 1 per cent; small lymphocytes 10 per cent; large lymphocytes 1 per cent; polymorphonuclears 89 per cent. February 16, 1932, sedimentation time thirteen min-

utes. March 7, 1932, hemoglobin 55 per cent; red cells 3,940,000; white cells 8900; small lymphocytes 18 per cent; large lymphocytes 2 per cent; polymorphonuclears 79 per cent; eosinophiles 1 per cent; sedimentation

FIG. 1. FIG. 2.

FIG. 1. Choriocarcinoma of left side of fundus of uterus. Somewhat enlarged uterus opened anteriorly. Tubes and ovaries are normal.

FIG. 2. Metastatic tumor in left lateroposterior wall of uterus just under peritoneum. Mass seen on section.

time sixty-five min. March 12, 1932, hemoglobin 65 per cent; red cells 3,500,000. March 19, 1932, hemoglobin 65 per cent; red cells 3,580,000; white cells 9600; small lymphocytes 20 per cent; polymorphonuclears 80 per cent.

X-ray of chest, February 13, 1932 was negative. On February 15, 1932 a pan-hysterectomy and a bilateral salpingo-oophorectomy was performed. The patient did well for a few days, then commenced to have pain in her chest, accompanied by coughing (blood tinged) and dyspnea. This continued several days and another *x*-ray was made, showing very slight hilus and bronchial changes with probably a little haziness over the left chest, being otherwise negative (Bethea).

Pathological report: Macroscopic: Specimen consists of uterus, tubes and ovaries. The uterus is slightly enlarged and when opened anteriorly presents a normal cervix and lower uterine segment. In the fundus, on the left side is found a bulging, ragged, reddish gray, very hemorrhagic, translucent, soft, mass, measuring $3 \times 3 \times 1.5$ cm. This mass appears to have started in the muscular wall of the fundus and extended into the uterine cavity (Fig. 1). Under the serosa in the muscle of the left lateroposterior surface of the uterus is a mass measuring $1.5 \times 1 \times 1$ cm. Externally, and on section this mass is also reddish gray, very hemorrhagic, translucent and soft (Fig. 2). A section through the mass in the fundus

and the uterine wall shows the former to have the same appearance, as it did externally, except that it is more translucent, especially so where it is infiltrating the muscle (Fig. 3). The ovaries are of usual size and contain

FIG. 3. Choriocarcinoma of left side of fundus of uterus, on section. Right side of uterus, right tube and ovary shown.

numerous small cysts, some with clear straw-colored fluid and others with a small amount of blood. No copora lutea are found. The uterine tubes are of usual size and appear normal.

Microscopic: The primary tumor consists of large masses of Langhans' cells and syncytium. The clear cytoplasm of the sharply outlined cells of Langhans' with their single, round or slightly elliptical, moderately dark nuclei contrast strikingly from the darker masses of continuous cytoplasm of syncytium containing here and there, larger, darker, elliptical nuclei. In places these are very large and in others many are crowded closely together. Many mitotic figures are seen, more common among the Langhans' cells. Neither stroma nor blood vessels are seen, but large intercellular spaces containing blood or serum are abundant. Hemorrhage with blood clot formation is extensive. Both types of chorionic cells, mostly in association with each other, are infiltrating, between the smooth muscle fibers of the uterine wall. Both types of cells stain well. No chorionic villi are seen. Polymorphonuclear leucocytic infiltration is of moderate amount (Fig. 4).

The metastatic tumor presents a histology in every way similar to that of the primary tumor, except for absence of the polymorphonuclear leucocytic infiltration (Fig. 5).

Operation was followed by *x*-ray therapy. A positive Aschheim-Zondek test was obtained on February 15, 1932 and on March 2, 1932. Following

report an examination was made of the vagina for metastasis (negative). On March 2, 1932 an *x*-ray of the chest was negative.

The patient left the hospital much improved and was instructed to

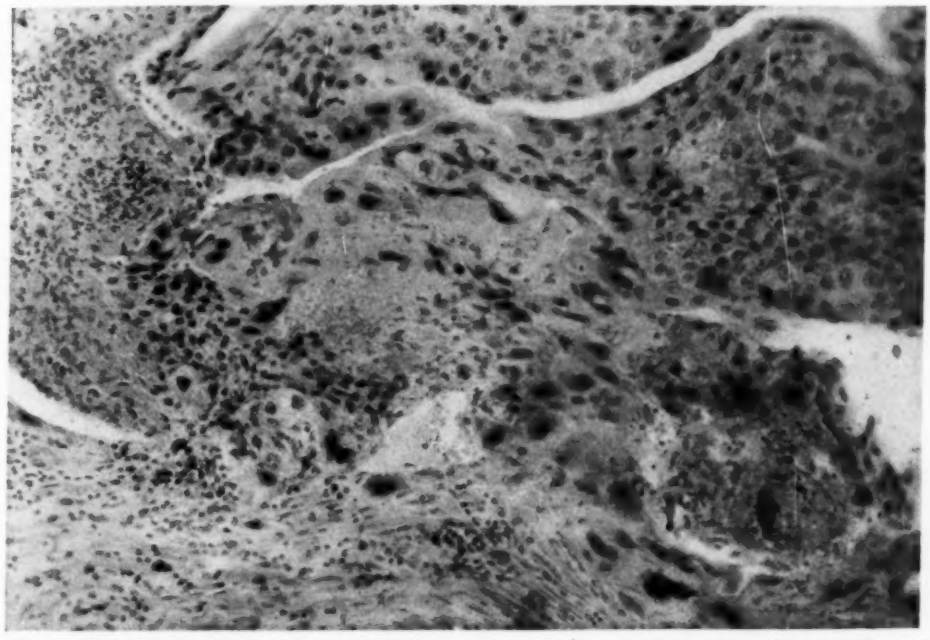

FIG. 4. Section of primary tumor. To right of center are seen clear Langhans' cells and to their left in center darker syncytium. Both types of cells, in association, are infiltrating between smooth muscle fibers of uterus, below. A large intercellular space filled with blood is seen in lower third of center. To left is seen extensive hemorrhage and polymorphonuclears. Photomicrograph × 200.

return in six weeks for observation. She returned in June, 1932, and the Aschheim-Zondek reaction was negative. No metastatic nodules were present. Health was improved. Another Aschheim-Zondek test was negative in September, 1932. From a preoperative and prognostic standpoint the Aschheim-Zondek test served a most useful purpose.

CASE II. Mrs. S., aged thirty-three years, white, entered St. Joseph's Hospital November 29, 1919, service of Dr. Black. She complained of pain in the lower left quandrant. Menstrual history was normal; three para; last menstruation November 16, 1919. There were no symptoms of early pregnancy. Pelvic examination revealed a uterus the size of a three and one-half months pregnancy. Due to absence of signs of pregnancy two *x*-rays were made (negative). Three other gynecologists failed to make a differential diagnosis between a uterine tumor and pregnancy. The patient was sent home and returned in a few days stating that the pain was much

worse and the tumor was larger. She stated that "there was no possible chance of being pregnant." An exploratory laparotomy was advised and performed on December 12, 1919.

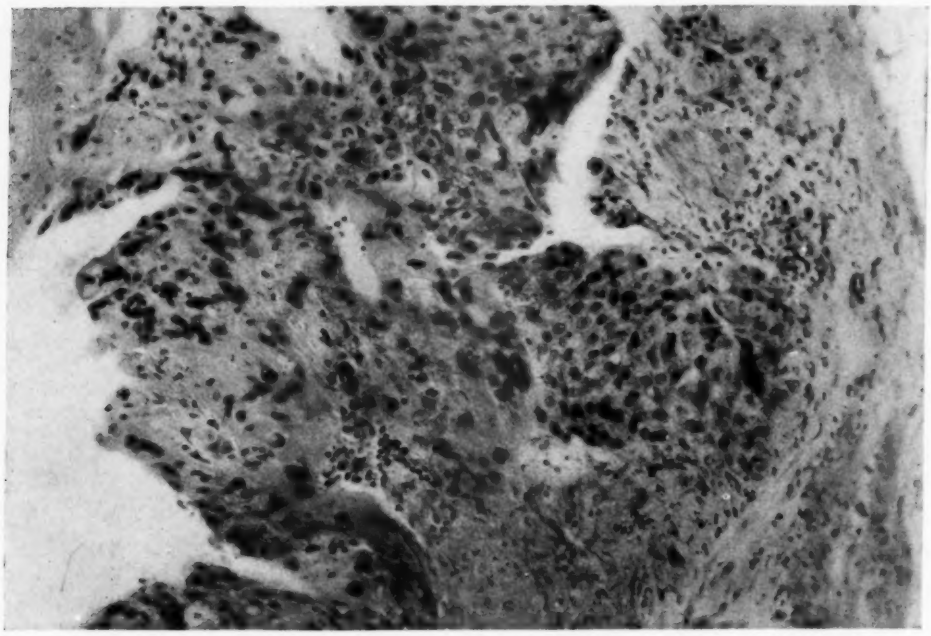

FIG. 5. Section of metastatic tumor. Histology is similar to primary tumor. (Fig. 4). To right of center are clear Langhans' cells. In center and to left of Langhans' cells is darker syncytium. Both types of cells, in association, are infiltrating smooth muscle of uterus on right. Intercellular spaces with serum are seen to left of center. In upper left corner is seen hemorrhage with an absence of polymorphonuclears. Photomicrograph × 200.

The mass extended up to near the umbilicus. Pregnancy was diagnosed and the abdomen closed. On December 25, 1919 the patient miscarried twins, one placenta, which had to be removed manually. Both fetuses had been dead for some time. She was discharged on the twelfth day. On January 11, 1920 the patient returned having bled profusely since the miscarriage. The uterus was large and flabby. Scrapings from a diagnostic curettage showed choriocarcinoma (Schmittou). On January 23, 1920 a pan-hysterectomy with double salpingo-oophorectomy was performed. The specimen showed a chorionic-looking growth in the uterus, which had extended through with much enlargement. The patient was discharged on February 24, 1920. The patient died a few weeks after leaving the hospital. No autopsy was obtained.

CASE III. Mrs. A., white, aged twenty-nine, primipara with abortion six years previous, was admitted to Methodist Hospital, service of Dr. Davis, March 9, 1931. She had missed her period in November, 1930. Early symptoms of pregnancy were present. On January 25, 1931 abortion occurred. Vaginal packs were used to control hemorrhage. Diagnostic curettage was performed on March 11, 1931. She remained in the hospital ten days. She gained in strength and weight after returning home for one month when she had another flow for eighteen days. She returned to the hospital in two months for uterine hemorrhage. Another diagnostic curettage was performed. She continued to bleed. The pathologist reported hyperplastic endometrium which is invaded in places by round villus-like areas of syncytial cells and Langhans' cells, which are still fairly well demarcated and show only a small amount of infiltration. Diagnosis: chorioepithelioma. On May 18, 1931 uterus, both tubes and ovaries were removed.

Pathologists reported the uterus larger than normal. Microscopic findings showed most of the endometrium removed by previous curettage. One area showed invasion of the mucosa by the rounded areas of syncytial and Langhans' cells with a moderate amount of surrounding chronic inflammatory infiltration. Ovaries and tubes were normal. Diagnosis: choriocarcinoma (Jamison). She was symptomatically well on December 1, 1932.

CASE IV. Mrs. B., white, aged eighteen, entered Baptist Hospital, service of Dr. Gordon, on August 14, 1927, for uterine bleeding. She had a temperature of 98°F. to 103°F. Pulse was fast and weak. Wassermann reaction was negative. Urinalysis: casts and albumen, many pus cells and red blood cells were present. Seven months before entering the hospital she had amenorrhea for two months and then had an abortion. Since that time she had bled continuously. Blood examination: hemoglobin 30 per cent (Sahli); red cells 2,200,000; white cells 11,000; lymphocytes 12 per cent; polymorphonuclears 34 per cent; mononuclears 44 per cent. An *x*-ray of the lungs on August 18 showed large shadows over lower portion of both lungs that were very suggestive of malignant metastases. One particularly large area showed over the heart shadow, almost one inch in diameter. The parotid glands were enlarged. There was a history of a premature six months birth, eighteen months before entering the hospital, without subsequent trouble.

The patient was extremely ill and continued to get worse until her death, August 26, 1927. Report of autopsy performed by Dr. Leake: the body is that of an emaciated woman about thirty years of age. There is a foul-smelling discharge from the vagina. A dark hemorrhagic mass springs from the anterior surface of uterus. Tubes and ovaries are negative. The

entire colon is spastic, the spleen is moderately enlarged. The stomach is markedly distended with gas and displaced downward. Both lungs show a peculiar yellowish discoloration and are covered over with small hemorrhagic nodules. Heart is negative. On removal of the viscera the left lung is adherent posteriorly to the diaphragm. There is a soft friable tumor in the base about 4 cm. in diameter. There are multiple small nodules scattered through both lungs, which have the same appearance. The uterus which is moderately enlarged contains a necrotic hemorrhagic mass, which involves the entire fundus. The mass springing from anterior surface of uterus has the same appearance as the tumors found in the lungs. This growth is 25 cm. in diameter, but not connected with the uterine cavity. The greater part of the vaginal wall is necrotic from the extention of the growth from the uterus.

Microscopic: Growths infiltrating the uterus and involving both lungs are composed of two types of cellular elements. One of these consists of irregular masses of protoplasm containing dark nuclei. These masses are arranged in islands and branching columns which form a network (syncytial cells). The other cell elements consist of irregular cells which lie in masses (Langhans' cells). Large hemogenous fibrous areas have been produced by necrosis of the tumor cells.

Anatomical diagnosis: Choriocarcinoma of uterus with extensive pulmonary metastasis.

This a typical choriocarcinoma.

CASE V. Mrs. M., Dr. Henning's case, white, aged twenty-seven, married, was confined four months previously. She had continued to have uterine hemorrhage since. She complained of tenderness over lower abdomen. Bimanual examination revealed a badly lacerated cervix, posterior lip hypertrophied. An indefinite inflammatory mass enfolded the broad ligaments. On November 26 a diagnostic curettage and biopsy of the cervix were carried out.

Pathologist report: The curettings and the cervix showed a profuse growth which invaded the muscular layers by Langhans' cells and syncytial cells and fairly closely packed masses separated by bands of muscular and fibrous tissue. Chorioepithelioma (Jamison). Radium and *x*-ray were administered. She was in good condition December 1, 1932.

CASE VI. Mattie M., aged thirty, colored, Dr. Smythe's service, August, 1916, passed a four months pregnancy. January, 1917, she commenced to have uterine bleeding and had bled up till the time she entered the hospital, April 23, 1917. The blood showed hemoglobin 15 per cent; red cells 1,152,000. A diagnostic curettage with a histological report of chorioepithelioma (McIntosh) was carried out. She was discharged on May 5, 1917, much improved. There has been no follow up record of this case.

The diagnosis of Case I, which was reported in detail, is a typical chorionepithelioma of Marchand (choriocarcinoma) of the fundus of the uterus with a metastatic tumor to the lateroposterior wall of the uterus. This case is typical for the reason of the histological findings, viz.: anaplastic and the intermingling of cells, the cells having no stroma, blood vessels or chorionic villi. The uterus was small and clinically there was malignancy. Eleven months later the patient was symptomatically well.

Case II was clinically typical choriocarcinoma, but the histological data have been lost. Case IV, both clinically and histologically, was a choriocarcinoma. The other 3 cases were also evidently choriocarcinoma.

CONCLUSIONS

1. A uterine hemorrhage, or a blood-tinged discharge following pregnancy (especially a hydatidiform mole) with a positive Aschheim-Zondek test, should arouse suspicion of a chorioepithelioma.

2. While 45.7 per cent of chorioepitheliomas follow moles, only about 1 per cent of moles are followed by chorioepithelioma: therefore, a hysterectomy or large doses of radium are not justifiable in young women with moles.

3. The diagnosis of typical cases of choriocarcinoma from the histological findings and clinical symptoms should not be difficult.

4. A pan-hysterectomy should be performed when a diagnosis is made, which should be followed by irradiation.

5. As embryonic cells are very sensitive to radium rays, radium is a good prophylactic and curative agent in chorioepithelioma in selected cases.

6. Repeated Aschheim-Zondek tests following moles and especially following hysterectomy for chorioepithelioma are of paramount prognostic importance.

7. Patients with mole pregnancies should be watched for several months. However, if an Aschheim-Zondek test is negative, one may feel reasonably assured of no further trouble.

NOTE. I am indebted for the pathological report of the specimen in Case 1 to Dr. Harry C. Schmeisser and for the photographs to Mr. Joseph L. Scianni, director and artist, respectively, of the University of Tennessee, Pathological Institute.

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DISCUSSION

DR. A. JOHNSTON BUIST, Charleston, S. C.: In our clinic in Charleston, during the past ten years, we have had 6 cases of mole and 4 cases of chorioepithelioma. In none of the cases of chorioepithelioma was there a previous history of mole and none of our cases of mole was followed by chorioepithelioma. There was one case of choriocarcinoma in which a hysterectomy was performed and where death followed some months later from pulmonary metastasis. The other 3 cases were of the chorioadenoma destruens type and all three patients recovered after hysterectomy.

The last case was that of a colored woman, aged forty-seven, who had had six premature deliveries and six full term pregnancies, the last child being born four years prior to her admission to the hospital, which was in March, 1932. About fifteen months prior to entrance she had had an amenorrhea of three months' duration and then what she took to be a return of her normal period. Since that time there had been a constant discharge of blood which at times was great and at times slight. An examination revealed a movable, slightly enlarged uterus containing a globular tumor, the size of a golf ball, situated to the left and just above the internal os. A diagnosis of carcinoma of the body of the uterus was made and a complete hysterectomy performed. An examination of the gross specimen showed that I had cut very close to the tumor externally. The pathological report showed that we were dealing with a chorioadenoma destruens, a destructive placental mole. An Aschheim-Zondek test made upon the receipt of the pathological report was negative. Twenty-one days after the operation there was a leak of urine from the vagina and an examination showed a vesicovaginal fistula, there being considerable ulceration anteriorly in the vault of the vagina. A cystoscopic examination showed that the ulceration extended into the bladder. The patient was watched for ten days and during that time the ulceration increased considerably. Six hundred milligram hours of radium was used in the vagina and a few days later the patient left the hospital with a discharge of urine from the vagina still present.

An examination made in November showed the fistula closed and no evidence of ulceration in the vagina or bladder and the patient feeling quite well.

The interesting points in this case were the facts that the Aschheim-Zondek test was negative in spite of the fact that some of the destructive placental mole tissue was still present and active and that cure of the growth and closure of the fistula responded so readily to radium. From a

study of the literature it would seem that radium has been used in so few of these cases that its effects are comparatively unknown. In this case its results were most satisfactory.

Dr. Wm. T. Black (*Closing*): The case reported by Dr. Buist is very interesting and is in keeping with other reported cases where regression of metastases followed the removal of the parent growth in the uterus. The regression probably follows the removal of this growth, due to the fact that the woman develops some lytic substance in the blood that destroys these chorionic epithelial cells. The case report by me was, I believe, a typical choriocarcinoma, which has been described by Marchand. The case reported in detail had metastasis to the lung, which regressed. The uterus was small and there was an absence of blood vessels and stroma, which would signify a typical chorioepithelioma.

SOME PHASES OF HYSTERECTOMY

F. Webb Griffith, M.D., F.A.C.S.

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WE must confess that the extirpation or resection of an important organ is an admission of defeat. We remove because we cannot satisfactorily cure.

Let us recall briefly the history of a few of the operative procedures of the past fifty years. Possibly there are some here who remember the time when the surgeon boasted of his dexterity in amputating an extremity and cited the large number of amputations which he had performed. Today it is with the greatest reluctance that an amputation is done.

We shudder when we think of the appalling havoc which has been wrought by the sterilization of thousands of women through the unnecessary removal of practically normal ovaries. It is one of the dark pages in the history of surgery.

We have just been passing through and I trust are near the end of a period of enthusiasm for pylorectomies and gastric resections in the treatment of benign lesions of the stomach. Surely we are justified in believing that the goal lies in the opposite direction, that is either by medical procedures or less mutilating surgery. Through the efforts of the urologist, conservative treatment of the kidney is becoming more successful and nephrectomy much less frequent.

It is to be hoped that in the progress of gynecology, a large series of hysterectomies will be regarded as are amputations, pylorectomies and nephrectomies.

During the past twenty-five years radium and *x*-ray have done a great deal in the treatment of certain uterine conditions. But radiotherapy is applicable only to a small proportion of those cases which are now being treated by surgery.

Before this Society there have been presented numerous papers discussing the relative merits of radium and surgery

in the treatment of carcinoma of the cervix, and for a number of years it was a topic of heated discussion among gynecologists. With few exceptions, however, I believe it is generally agreed that radium is now the choice in such cases.

It was my privilege two years ago to stand beside Mr. Victor Bonney as he operated upon 3 patients with carcinoma of the cervix. Mr. Bonney is probably the greatest proponent of surgical treatment of carcinoma of the cervix, and in his hands,with his low mortality and high percentage of apparent cures, surgery instead of radium may be the procedure of choice. However, we are not all Bonneys. On the other hand, the greatest of living gynecologists, our own beloved Dr. Howard A. Kelly, has practically abandoned surgery for radium in the treatment of these cases. I think I have operated upon my last patient for carcinoma of the cervix.

Hysterectomy for carcinoma of the body of the uterus gives such excellent results even in the fairly advanced stages, that it appears to be far preferable to radium, even though it carries a definite operative mortality.

During the past few years numerous articles have appeared upon the subject of hysterectomy. The statistics contained in them have varied widely. For example, there is the report from the Mayo Clinic for 1928, where we know the gynecological work is done by a few men, all of whom are master surgeons. That report gives a hospital mortality of less than 1 per cent in 470 cases of hysterectomy for benign conditions. On the other hand, in hospitals where the work is done by numerous visiting surgeons and residents, the mortality is markedly higher.

Fullerton and Faulkner, November, 1930, reported 1851 hysterectomies done by the visiting staff and the residents of Lakeside Hospital over a period of thirteen years. Their gross mortality for 1078 pan-hysterectomies was 4.1 per cent, for 609 supravaginal hysterectomies, 4.4 per cent.

Drs. L. E. and J. C. Burch in May, 1931, reported 200 consecutive hysterectomies from the Vanderbilt Hospital.

Of these, 166 were supravaginal with a mortality of 4.2 per cent, and 32 were pan-hysterectomies with 3.1 per cent mortality.

Bartlett and Simmons report from the Free Hospital for Women, Brookline, 2733 supravaginal hysterectomies with a mortality of 1.7 per cent, 209 total hysterectomies (exclusive of carcinomata of the cervix) with a mortality of 7 per cent and a combined mortality of the supravaginal and total hysterectomies (exclusive of carcinomata of the cervix) of 2.1 per cent.

From the Cook County Hospital a recent report of 661 abdominal supracervical hysterectomies with bilateral salpingo-oophorectomies gave a mortality of 8.9 per cent.

In order to determine the results of hysterectomy in the hands of an average surgeon in an average hospital, I have reviewed 693 consecutive abdominal hysterectomies, exclusive of those done for carcinoma of the cervix. These operations were all done by me and therefore have more of less uniformity for comparison. I shall not discuss vaginal hysterectomy, and with chemical hysterectomy I have had no experience.

Surprising as it may seem, there is still some confusion as to terminology. The word pan-hysterectomy has been used by some to designate the removal of the adnexa. Correctly speaking, pan or total hysterectomy designates the removal of the uterus together with the cervix. Sub-total or supravaginal hysterectomy denotes removal of the uterus but not the vaginal portion of the cervix. Supracervical is correctly used to designate an amputation just above the internal os, and designed to leave a small amount of uterine mucosa. None of these terms includes removal of the adnexa.

The 693 cases are classified in five general groups.

I. FIBROIDS

Suffice it to say that the mere presence of a fibroid is not an indication for surgery. It must be producing symptoms sufficient to warrant its removal or else be large enough to

make us believe it is causing undue pressure on the neighboring organs which in time would lead to trouble. As a purely arbitrary division, I would say that if the growth is as large as a grapefruit it should receive treatment. There are 148 in this group classified as fibroids and a large percentage of these, especially in the colored, were complicated by a definite pelvic inflammatory disease. By that I mean not merely the mild inflammatory reaction resulting from the presence of the tumor but a distinct bilateral tubal infection and plastering down of the adnexa. In at least one-third of these cases, this pelvic infection of itself would have been sufficient to have brought the patient to the surgeon. There were 50 colored patients, or 33.5 per cent. The percentage of colored patients in the total 693 was 26 per cent, simply verifying what has been long known, that the percentage of fibroids is much higher in the colored race.

The sub-total operation was done 135 times and the total operation 13 times. There were 4 deaths, giving a hospital mortality of 2.7 per cent. As a matter of secondary interest the appendix was removed in 89 cases and had been previously removed in 22. The 4 deaths were, briefly, as follows:

CASE I. A colored woman, aged thirty-six, married, had a fibroid about the size of a grapefruit, but with very marked, probably neisserean, pelvic inflammatory disease. The operative procedure was supravaginal hysterectomy, double salpingo-oophorectomy, appendectomy. She died about ten days after operation from pneumonia.

CASE II. Colored woman, aged forty-five, married. The record states that there was an adherent fibroid the size of a cabbage, together with the usual pelvic inflammatory disease so common in the colored. The operation consisted of supravaginal hysterectomy and double salpingo-oophorectomy. The patient collapsed on the table and died from shock five hours later.

CASE III. White woman, aged fifty-three, married. There were multiple fibroids filling the pelvis, also a solid tumor of the left ovary the size of an orange. The operation consisted of supravaginal hysterectomy and left salpingo-oophorectomy. About a week later, a second operation was necessary. The right tube and ovary had become necrotic with formation of a localized abscess beginning. The patient did not respond after the second operation

and died in two days. I do not recall now why a tube and ovary were left behind in a patient fifty-three years old. Possibly it was because the patient felt, as do many, regardless of their age, if one ovary was left behind she would not be entirely unsexed. Whatever the reason which influenced me to leave an ovary in a woman fifty-three years old, that death must be attributed to an error in surgical judgment; first in leaving the ovary, and then by interfering to too great an extent with its blood supply.

CASE IV. A white woman, aged forty, married, on admission was quite anemic with hemoglobin about 20 per cent. She was kept in the hospital for two weeks until, following transfusions, the hemoglobin reached 40 per cent. She did well for about a week and then gradually lost ground and died.

It is in those cases of fibroids where one or both ovaries can be safely left, that the supracervical hysterectomy so frequently is adaptable. The patient retains a semblance of menstruation and it is reasonable to believe that even this small amount of uterine activity will preserve the ovaries from atrophy longer than if there had been an ordinary subtotal or total hysterectomy.

Some clinics report a fairly large number of myomectomies in comparison to the hystero-myomectomies. I confess I have had relatively few. In nearly all the cases there has been either the complicating tubal infection, the multiplicity of the fibroids, the age of the patient (around forty) or some other factor which would contraindicate myomectomy.

I have had only a few cases treated by radiotherapy instead of surgery. For this there are several reasons. In the first place so many of the patients have complications which can be treated at the same time by surgery but are not amenable to radiotherapy. Secondly, in many cases at least one ovary can be saved to lessen the symptoms of artificial menopause. Thirdly, there is the economic factor. If we could assure the patients positively that the financial outlay necessary for radiotherapy would be the end of their expense, I feel sure many more patients would have been submitted to that procedure. When, however, in cases that seem to be suitable for *x*-ray or radium, it has been explained to the patients

that they may still have to resort to surgery, it has been my experience that most of them would rather have the operation and be done with it, than run the risk of an added financial burden.

2. INFLAMMATORY GROUP

In this group were 315 patients, of which 95 were colored and 220 white, which makes the operation in the colored patients 30 per cent of the total. As the average of the whole series shows the colored patients comprise 26 per cent, this again demonstrates what we already knew, that the operation for pelvic inflammatory disease is relatively greater in the colored. The sub-total operation was done in 307 cases and the total in 8. One hundred fifty-three were drained and 162 were not drained. That nearly 50 per cent were drained was due largely to the fact that, in the first part of the period covered by this series, frequently we operated in the subacute stages and therefore necessarily drained. Also a few years ago we were more in the habit of draining the chronic quiescent cases, a procedure which is now seldom followed. When we found it necessary to remove both tubes and ovaries we nearly always removed the uterus.

In the sub-total hysterectomies it is our custom routinely to cup out the cervix. This is done primarily to lessen the persistent leucorrheal discharge and to make for better coaptation in closure of the cervical stump. It may also help, at least theoretically, to eradicate a focus of infection. It is not done with any idea of preventing a future cancer. It has been estimated that probably two-thirds of all cervical cancers arise outside of the cervical canal; therefore we can readily see how little cupping of the cervix acts as a prophylactic against cancer. Parenthetically I may state that in the 604 cases of subtotal hysterectomy we have been able to find but one case of cancer arising from the stump. In that case it was an epidermal carcinoma, grade 3, and developed approximately nine years after the operation.

In performing hysterectomy in the non-inflammatory cases, it is usually wiser to err on the side of extreme conservatism when dealing with the ovaries. However in the inflammatory cases when it is necessary to dig an ovary out of adhesions or when the ovary is moist and we know that it will be plastered down within a few hours, I believe it is the better part of wisdom to be more radical. I am sure that any one doing pelvic surgery has seen many cases where the zeal in trying to save such an ovary has necessitated a second operation. While I have no statistical proof, I am convinced that the symptoms of artificial menopause are less pronounced following bilateral oophorectomy for pelvic inflammatory disease, than in the non-inflammatory groups where bilateral oophorectomy is done. This may be explained by the fact that the relief of pain is so grateful to the former group that they minimize the unpleasant effects of the artificial menopause. It is possible also, that in many of the pelvic infections the ovaries are, to some degree, destroyed before their removal. While we occasionally have severe nervous manifestations following double oophorectomy, it has not been the bugbear which some writers have described. This may be due to the fact that a large proportion of our patients are of the sturdy mountain stock accustomed to a more or less out-of-door life, in contrast to those highly strung patients seen in the congested urban centers. In 229 of this group the appendix was removed. In 37 it has been previously removed.

In the 315 hysterectomies there were 5 deaths or a hospital mortality of 1.6 per cent. They were briefly:

Case v. A white woman, aged thirty-six, was operated upon three months after delivery. The uterus and adnexa were friable. The patient left table in a very poor condition and died two days later.

Case vi. Colored woman, aged twenty-seven, with a pelvic abscess filling the whole pelvis. The patient did not pick up well after operation and died in two days. Had we been content just to drain the abscess the chances are she would have lived.

Case vii. A colored woman, aged forty-four, in spite of conservative treatment was rapidly getting worse. Operation revealed general peritonitis

with a pelvic abscess. The patient died in a few hours from shock. The operation lasted only about thirty minutes but viewing the case in retrospect we believe it would probably have been better simply to have instituted drainage and quit.

CASE VIII. White woman, aged thirty-four, married. The operation was for bilateral hydrosalpinx. The patient left the table in good condition and for twenty-four hours small amounts of urine were secreted. About forty hours after operation she died from what appeared to be acute suppression of urine.

CASE IX. White woman, aged forty-one, single. At a previous operation the right tube and ovary and appendix had been removed. The present operation was for removal of the uterus and the bound-down left tube and ovary. The patient did nicely for about four days and then rapidly grew worse and died with symptoms pointing to acidosis but in reality we do not know the cause of her death.

3. SO-CALLED FIBROUS GROUP

Under this vague heading I have included that group of patients usually in the late thirties or early forties who have an enlarged boggy uterus, frequently acutely retroflexed, usually moderately prolapsed. There is nearly always an accompanying relaxation of the pelvic floor. These patients have had more than their share of children and are literally worn out. If any symptoms suspicious of carcinoma of the body of the uterus were present the case is not included in this group but in the following group of suspected malignancy. In these cases perineal work, including trachelorrhaphy, if necessary, is first done, followed by a supracervical hysterectomy, retaining of course the adnexa. This will usually relieve the patient of her symptoms and still maintain a semblance of menstruation. The development of carcinomata in the remaining stumps is not frequent enough to justify total hysterectomy in these cases as a routine. There were 150 cases in this series, of which 138 were subtotal or supracervical and 12 total. There were 27 colored patients, or 18 per cent. With the colored patients comprising 26 per cent of the whole series, the 18 per cent does not mean that this pathology is not as frequently found in them, but rather that with their phleg-

matic temperament and ability to stand discomfort it takes more than a sagging boggy uterus with a relaxed perineum to bring them to operation.

We know that radiotherapy will cause these enlarged boggy uteri to shrivel up but at the same time artificial menopause is produced and the pelvic relaxation remains. Of course in the allied group where there is no lack of pelvic support but where there is a big boggy bleeding uterus (non-malignant) but in good position, *x*-ray or radium would be the procedure of choice. Incidentally the appendix was removed in 113 cases and had been previously removed in 11 cases. There were 4 deaths or a mortality of 2.7 per cent. They were:

CASE X. White, aged forty, married. On the fourth day postoperative, without apparent reason, the pulse became rapid and feeble, with moderate dyspnea, and the patient died in about ten hours.

CASE XI. White, aged thirty-nine, married. The patient did nicely until the eleventh day postoperative, when she complained of a tightness and feeling of distress in the chest, with dyspnea. This practically cleared up but three days later recurred suddenly and severely and the patient died in one-half hour.

CASE XII. A white woman, aged thirty-nine, married, left the table in good condition and reacted well from the operation. About twelve hours after operation she suddenly complained of pain in the precordium and died within thirty minutes.

CASE XIII. A white woman, aged thirty-nine, married, had a subtotal hysterectomy, appendectomy, perineorrhaphy, and hemorrhoidectomy. She left the hospital in two weeks slightly unbalanced mentally. Five weeks after the operation she was brought back to the hospital complaining of severe pain in the lower right abdomen, with temperature 102°F., and a high leucocyte count. A second operation revealed the right tube and ovary in a necrotic mass. This was removed and drains inserted. The patient died five days later. This is the second case in the whole series in which interference with nutrition caused necrosis of a remaining tube and ovary.

4. SUSPECTED CARCINOMA OF THE BODY OF THE UTERUS

In this group there were 56 cases in each of which there was some symptom at least slightly suspicious of malignancy of the body. In a number of these, malignancy was proved

by preliminary curettage. However, only in the past few years has a competent pathologist been available for immediate diagnosis and it was therefore necessary to send the scrapings to a distant city. For that reason when a patient with symptoms suggestive of malignancy, but with other pathological conditions necessitating operation, as described in the preceding group, we would operate and then send the specimen to the pathologist. The important point however, is that a total hysterectomy was invariably done. Now, with a competent pathologist always available we no longer have to resort to this semi-empirical method.

Strange to say there was just one colored patient in the 56. There was one death, a mortality of 1.8 per cent.

CASE XIV. A white woman, aged fifty-seven, married, did nicely for fourteen days and had just been put back to bed after having been in a chair for an hour. She died suddenly before a physician arrived.

5. MISCELLANEOUS

In this group there were 24 cases of various conditions. Most frequent were the bilateral ovarian cystomata, adherent to the uterus. There was one Porro cesarean section in a woman forty-three years old who had been submitted to numerous pelvic examinations. There was also a second case of Porro cesarean section upon a woman aged thirty at full term in whom the uterus had ruptured twenty-four hours previously, the rupture having occurred through a former cesarean scar. There were 2 cases of intractable dysmenorrhea in which the patients had become mild narcotic addicts. These 24 cases were all sub-total hysterectomies. There was one death, giving a mortality of 4 per cent.

CASE XV. White woman, aged thirty-one, married. The operation was for release of postoperative adhesions. The patient had a deformed pelvis and since puberty had suffered violently for three days at periods. At the urgent request of the patient and her husband, and with the sanction of a consultant, after releasing the omental adhesions, a supracervical hysterectomy was done. Three days after operation the patient died suddenly with symptoms of pulmonary embolus.

The mortality in the total series of 700 cases was 2.15 per cent.

SUMMARY

1. We hope and believe that the present indications for hysterectomy will be met to a great extent by other yet unknown but less radical measures.

2. Radium is the treatment par excellence for carcinoma of the cervix, while surgery is just as strongly indicated in carcinoma of the body of the uterus.

3. The mortality following hysterectomy in the different clinics varies from less than 1 per cent up to practically 9 per cent.

4. The mortality in this series of 693 hysterectomies done by one average surgeon was 2.15 per cent. Certainly therefore double that mortality, or 4.3 per cent should be the upper limit in any reputable hospital.

5. The greatest conservatism should be practiced in dealing with the ovaries in the non-inflammatory groups but in the cases of pelvic inflammatory disease we are justified in being more radical.

6. The healthy out-of-door life of the woman in the country is an important factor, tending to lessen the severity of the artificial menopause.

ACUTE SUPPURATIVE CHOLANGITIS

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THE usual conception of acute suppurative cholangitis is that of cholecystitis and cholelithiasis, and probably common duct obstruction, causing retrograde infection and suppuration in the bile-ducts of the liver. Gallstones are the most frequent antecedent of suppurative cholangitis, being present in 90 per cent of the cases. Such stones generally may be found at operation, with visible evidence of inflammation of the gall bladder.

In the case of suppurative cholangitis to be reported no stones were demonstrated at the time of operation, and the gall bladder appeared to be normal. A smear taken from the mucosa of the gall bladder, however, later grew streptococci, and autopsy revealed gallstones in some of the tributaries of the hepatic duct. Autopsy also showed no obstruction in the common duct, and very little evidence of inflammation. To the touch and unaided eye the common duct was a normal tube.

The patient was a negro male, aged thirty-five, who entered the Grady Hospital, March 27, 1932, complaining of pain in the abdomen, sweats and chilly sensations. His pulse was 104, respiration 22, and temperature 103.6°F. Three days before admission, while "heading" a bale of cotton, the pain suddenly appeared in the region of the umbilicus. His suffering for half an hour was intense, but gradually grew less, and pain was felt only intermittently when he entered the hospital. During this time he said he had considerable diarrhea, but had taken strong purgative medicine. During the preceding five weeks the patient had experienced several attacks similar to this one, but less severe. Upon close inquiry no history of previous illness could be obtained, except for several months he had noticed a hard lump on the right side of the rectum, which proved to be an unhealed fistulous tract, with considerable discharge. He was a well-developed negro, apparently very sick; the eyes were deeply jaundiced, the heart and lungs normal. The abdomen was distended, was rigid in the upper half, and slightly tender. The liver was only moderately increased in size, and the spleen was not felt.

April 11, a roentgenogram of the abdomen with barium enema showed only a dilated colon; the chest was negative. Typhoid, malaria and other fevers were ruled out by the laboratory, and there was no response to quinine therapy. The sputum and stools were negative; no light-colored stools were noted. Ameba could not be demonstrated. One blood culture proved to be positive for staphylococci, and autopsy showed bacteria-laden emboli in the blood vessels of the liver. The icterus index was 37.5, the blood Wassermann reaction was negative; the van den Bergh test was not made. The patient's blood counts were normal for the first two weeks he was in the hospital, after which the leucocytes rose to 11,000, with polymorphonuclears 84 per cent. The temperature ran a septic course, varying from 98° to 103.6°F., pulse from 70 to 130.

Many diagnoses were ventured by those who studied the case, such as tuberculous peritonitis, liver abscess, acute cholecystitis, pancreatitis, subphrenic abscess, portal thrombosis or pylephlebitis, and cholangitis. Tuberculous peritonitis is always a diagnosis difficult to exclude in a patient presenting this picture, especially in the negro race. In hepatic abscess the liver usually is larger than was shown in this patient.

The differential diagnosis between suppurative cholangitis and pylephlebitis, or suppurative portal thrombosis, often cannot be made until autopsy. The same general symptoms accompany both conditions. Jaundice is more frequent, appears earlier, and is more marked in cholangitis, while splenic enlargement often is more prominent in pylephlebitis. According to Libman[1] blood cultures are negative in pylephlebitis and positive in cholangitis. The two diseases may co-exist. Suppurative thrombosis of the portal vein follows suppuration in the area drained by this vessel, such as the appendix. It was suggested that this case was one of pylephlebitis with the focus in the rectal abscess.

Operation, April 15, under gas anesthesia, showed a jaundiced peritoneum. There was no free fluid or tubercles. The liver was slightly enlarged, normal in color, and indurated in the right lobe as usually seen in abscess. This indurated area was aspirated in six or eight places with a needle of large caliber, but no pus obtained. The head of the pancreas was swollen and hard. The gall bladder was moderately distended. Several enlarged

[1] LIBMAN, E. *Am. J. M. Sc.*, 136: 548, 1908.

glands were felt in the portal fissure. The gall bladder was opened, and contained normal-looking bile and no stones. The mucous membrane seemed healthy, but a culture taken at this time later grew short-chain streptococci. Cholecystostomy was done. The common duct appeared to be of normal size and consistency. There was no evidence of disease in the spleen or appendix. The anal fistula was opened and packed. Five days later it became necessary to perform suprapubic cystotomy for urinary retention, probably due to urethral stricture. The prostate was not enlarged, and no tumor was present in the rectum.

The patient died nine days after the abdominal operation. Autopsy showed a liver weighing 1900 gm. All the biliary ducts were enlarged, and dissection found them filled with greenish, purulent exudate throughout, even into the smallest terminal branches. The gall bladder was empty, and showed no inflammation or pus, nor leakage from around the cholecystostomy tube. There was an abscess in the head of the pancreas, and the pancreatic ducts were filled with pus. Smears demonstrated no amebae, but numerous streptococci and staphylococci. A few small stones were discovered in some of the branches of the hepatic duct. The anatomical post-mortem diagnosis was suppurative cholangitis and pancreatitis.

The clinical history of this case, with the indurated, somewhat enlarged liver, and the thickened head of the pancreas should have indicated that pus was present in these locations, and should have suggested that drainage of the common duct was the best procedure to follow. At the time of the operation the pathological process was so far advanced that it is doubtful if any procedure could have saved the patient. However, drainage of the common duct seems to be the logical treatment for suppurative cholangitis, although some textbooks give drainage of the gall bladder as the surgical treatment. The presence of an apparently normal gall bladder does not preclude the existence of pus in the bile-ducts of the liver, notwithstanding the fact that all the bile passages comprise an anatomical and physiological unit. An abundant lymphatic supply connects the various portions of the biliary system, so that inflammation of one part should be, but is not always manifested in another part.

The causes of suppurative cholangitis may be enumerated as follows: (1) Those conditions which diminish the resistance

of the ducts, such as past or chronic inflammation, dilatation due to tumor, or some other cause of obstruction such as stricture or outside pressure. (2) Those conditions which render the ducts more susceptible to infection, such as stagnation of bile, the presence of gallstones or tumor, rupture of hydatid cysts into the ducts, or the presence of intestinal worms in the ducts. (3) The spread of pyogenic infections from an abscess of the liver. (4) Severe general infections, such as typhoid fever, pneumonia and influenza. The first two causes are the commonest.

Rolleston[2] states:

> The mucous membrane of the ducts is swollen from inflammatory exudation and irregular from ulceration. The outer walls of the duct are also thickened and inflamed, and by extension there may be local peritonitis, which may lead to obliteration of the foramen of Winslow, or to suppurative pylephlebitis. The glands in the portal fissure are enlarged and soft. Possibly some of the areas of suppuration in the liver may arise as pericholangitic abscesses in connection with the lymphatics. The suppurative process in the ducts may be associated with an empyema of the gallbladder.
>
> The liver is nearly always greatly enlarged, swollen, and of a greyish color, with yellowish-green areas around the portal spaces. These foci are softening down into suppuration, and in early stages may, to the naked eye, resemble secondary new growths or even lymphadenoma. When the disease is fully developed, the bile-ducts may be enormously dilated so as to be as large as the small intestine, and have even been opened during laparotomy for supposed suppurative cholecystitis. The suppurating ducts may terminate in small abscesses on the surface of the liver, somewhat resembling the condition of the lung in acute bronchiectasis. Numerous biliary abscesses may be scattered throughout the liver, both on the surface and in its substance, and adjacent abscesses may run together and form a confluent or areolar abscess which shows fibrous septa. On the other hand, there may be a single localised abscess, or only a few small abscesses formed of ampulla-like dilatations of the ends of the ducts. The pus is often bile-stained, and may contain soft, calculous matter like brown mud. In the substance of the liver abscesses may form outside the ducts, possibly in the lymphatics, and suppuration may extend into the branches of the portal vein, causing pylephlebitis and diffuse suppuration of the portal spaces.

[2] Rolleston, Sir H. Diseases of the Liver, Gallbladder and Bile-ducts, Lond., Macmillan, 1929, pp. 727–28.

The suppuration may spread into Wirsung's duct and set up suppurative pancreatitis, and, by further extension of infection to the peritoneum covering the pancreas, a local abscess in the lesser sac of the peritoneum. Suppuration may spread from the pancreas into the portal vein and set up pylephlebitis.

The suppurating bile-ducts may leak into the peritoneum and cause general peritonitis or a local peritoneal abscess. Abscesses on the convex surface of the liver may perforate the diaphragm and cause an empyema or broncho-biliary fistula; abscesses on the under surface may open into the colon or set up a perinephric abscess.

Microscopically the larger portal spaces are dilated, and relics of their fibrous tissue are visible, but it may be difficult to distinguish the remains of the large bile-ducts from those of the portal veins, since both may be involved in the same suppurative process. The walls of the ducts may be destroyed and replaced by small cells which extend into the surrounding liver substance. There may be comparatively well-formed fibrous tissue from chronic pericholangitis, but the chief feature is diffuse small-celled infiltration. In places the liver cells can barely be recognised, and the condition is that of a commencing abscess.

The etiology of this case is not clear. Evidently the acute condition was preceded by chronic cholangitis, although the patient claimed to have been in perfect health before the sudden onset of his last illness. The stones found in the liver ducts may have produced the obstruction necessary for the subsequent infection and suppuration. Tietze[3] believes that spasm of the sphincter of Oddi is an important agent of the biliary obstruction. He writes that many patients who have gallstone colic say that often during the attacks their stools are colorless for a time, and with the subsidence of symptoms the normal color is restored. In one of his patients the common duct was of moderate size and did not contain any stones. A tube was passed through the opened cystic duct into the common duct, and then removed, and the opening in the cystic duct not closed. After some weeks the patient had a severe attack of colic which lasted several hours. The next morning a biliary fistula developed. It healed in a short time, but reopened whenever the patient had an attack of colic. Each time

[3] TIETZE. Treatment of cholangeitis. *Bruns' Beitr. z. klin. Chir.*, 134: 396, 1925.

during such attacks the stools were colorless. The urine contained bile pigment and mild jaundice appeared. According to Tietze the condition could not be explained as having been due to stones, for even though the stones had been overlooked the fistula would not have closed each time between attacks. If such spasmodic closure of the common duct does take place it may prove an etiological factor in cholangitis by bringing about stagnation of bile.

This writer (Tietze) declares that his results from draining the common duct in suppurative cholangitis have been poor, although he claims to have cured 2 cases of acute yellow atrophy of the liver by the operation, and gives infectious cholangitis as one of the causes of acute yellow atrophy. He says that most of the patients treated for cholangitis by common duct drainage die of secondary hemorrhage, infection or liver insufficiency. As a substitute operation Tietze suggests anastomosis between the common duct and adjacent part of the stomach. The only patient upon whom he had performed this operation, previous to 1926, died from hemorrhage from the abdominal wound the day after the procedure. This patient also had intermittent biliary colic and jaundice due not to stone or other obstruction, but he believes due to spasm of the sphincter of Oddi. Connecting the common duct to the stomach does not appear to be a very feasible procedure in a patient suffering from acute suppurative cholangitis.

[For Discussion see p. 689.]

ABSCESS OF THE LIVER, CHRONIC FORM

REPORTS OF THREE CASES

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ACUTE abscess of the liver has evolved a very extensive literature. In searching through the available literature, I have been unable to find any reports of chronic abscess, but, here and there, many cases are reported which were of considerable duration. The distinguishing feature of the 3 cases which I wish to report is that they range in duration from five years to more than twelve, during which time these patients were potential liver cases. All of them were incorrectly diagnosed. In the following reports, I shall give the histories in somewhat brief form and try to emphasize the points of interest to surgeons.

Acute abscess of the liver is a well-recognized entity and the diagnosis is usually fairly easy if and when the disease is suspected. It is true that there are many cases which present diagnostic difficulties, both from the nature of the ailment, and also from the associated pathological conditions.

ANATOMY OF THE LIVER

Detailed description of the anatomy of the liver is not necessary, but, a short outline of the features of the liver which have a direct relation to the pathology and the symptomatology may aid somewhat in clearing up the obscurity of the symptoms and the chronicity of the ailment.

The liver is situated in the upper vault of the abdomen and fits accurately to the under surface of the diaphragm. The liver is attached to the diaphragm by peritoneal sheets which suspend it rather loosely; these ligaments, for the purpose of description, have been given names. The greater part of the liver is covered with peritoneum, but on its superior and pos-

terior aspects the peritoneum leaves the liver and becomes attached to the under surface of the diaphragm. The area inclosed within the ligaments is not covered with serosa and is directly, but loosely connected with the diaphragm by a fold of peritoneum called the ligamentum coronarium. The liver is attached to the anterior portion of the diaphragm and the abdominal wall as far down as the umbilicus by a fold of peritoneum called the ligamentum falciforme. Within this last ligament run the fetal structures from the placenta to the liver which are represented in adult life as vestigial remains. This ligament acts, also, as a suspensory ligament of the liver. Below and behind the liver, the arteries, veins, lymphatics and nerves pass from and to the liver; these also form a supporting structure and help to fix and hold the liver in position.

Although the liver was formed, embryologically, in the ventral mesentery, like the spleen and pancreas, it has no definite attachments to the body wall, except as already described. These are loose and variable, except those fixations which are formed by means of the vessels. A further description is not necessary to the purpose of this paper.

PHYSIOLOGY OF THE LIVER

The liver is the largest gland in the body and one of the most accessible to study and experimentation. However, very little is actually known that is of real value.

Although the liver is very large and has important functions, no other organ can suffer so great a loss of substance and still maintain all of the necessary functions with which to carry on the normal processes of the body. More than 70 per cent of the liver substance can be destroyed and the remaining part of the liver can carry on the needed functions. A regeneration of liver tissue occurs. This characteristic of the liver explains why so much can be destroyed by an abscess and the body functions continue. This fact has great bearing upon other diseases of the liver also.[1]

Any inflammatory disease of the liver, if confined to the liver tissue itself, may run a prolonged course with few or no symptoms. It is when adjacent structures become involved that symptoms arise calling attention to liver disease. Pain sense is very low in the liver tissue. Unless there are general symptoms such as arise from infection, toxemia, debility, etc., there may be no symptoms at all, except a general feeling of low-grade ill health.

It is surprising how much of the liver can be destroyed by an abscess without the patient being much the worse for it. In one of my patients, a greater part of the right lobe was filled with a chronic abscess and the patient had been doing fairly heavy manual labor in the oil fields; he was not jaundiced nor did he display any other symptoms of any disease of the liver, except when he had an acute exacerbation.

CASE REPORTS

CASE 1. Twelve years before I saw this patient, she was suffering from some obscure liver symptomatology. She was *x*-rayed by two well-trained men who diagnosed gallstones. Her health was subnormal and she continued to have periods of recurring obscure pain in the upper right abdominal quadrant; she had occasional spells of low-grade fever lasting weeks and months, chronic indigestion, etc., with varying periods of apparent recovery. She never had any serious acute attacks. She had, at various times, tenderness in the liver region and mild, right shoulder pains, an aching in the shoulder rather than real pain. She spoke of her pain as a tender area around the tip of the shoulder blade. The digestion was often upset and her general health was never robust. This condition continued until about two years ago, when she had an attack of rather acute pain and soreness in the region of the liver with a continuous, low-grade fever for several months. She then had slight jaundice for a prolonged period and her physician diagnosed her disease as hepatitis.

Three months before I saw her she had an acute attack with all of the symptoms exaggerated. She had fever ranging from 102° to 104°F. at times; rigors were frequent; she was slightly jaundiced, had profuse sweats, considerable nausea and vomiting; in other words, she had all the symptoms of a localized septic process. There was constant, dull pain in the region of the liver and also in the right shoulder. The patient on entrance to the hospital was critically ill; she had a temperature of 98°F., pulse of 92 and

respiration of 24. She was very weak, emaciated, pale and complained of an indefinite pain in the whole liver region and upper abdomen. There was tenderness in the liver region, centered along the rib margin about 2 inches from the gall-bladder region. The liver was enlarged below fully three fingerbreadths and above for the width of one rib. The left lobe was not enlarged. There was marked tenderness in front and behind the right lobe of the liver. There was a definite swelling in the region of greatest tenderness. The abdomen was distended and tense along the rib margin on the right. Otherwise the examination was negative. The diagnosis was abscess of the right lobe. This was confirmed at operation. On admission to the hospital the blood showed the white cells to be 14,000, polymorphonuclears 73 per cent and small lymphocytes 27 per cent. The urine showed a faint trace of albumin, many pus cells and many flat epithelial cells.

Case II. The history dates back five years ago, when she began to suffer from a severe pain in the right hypochondriac region, in the region of the liver and in the back along the angle of the ribs and up in the region of the shoulder blade. The pain was severe enough to require the use of morphine. She was not jaundiced, but had fever for several weeks. The family used osteopaths and one had the care of this patient. She soon got over the acute stage of the illness and was more or less a chronic invalid from that time until the onset of the present illness. She never had another acute attack, but she was frequently upset with febrile attacks of low degree, acute indigestion, pain of moderate intensity in the region of the liver, occasional jaundice and with frequent periods of soreness in the right side of the back behind the liver and in the region of the right shoulder blade. Her health was constantly subnormal. She never gave any history of diarrhea, dysentery or other bowel upset. She was questioned very carefully as to this. No other cause could be found to account for her state of health.

The present illness began one week before coming to the hospital, with a severe pain in the region of the gall bladder. It was apparently paroxysmal. She had been having a low-grade fever for several months and she was in a state of poor health. She described the pain as a pressure in the whole liver region which was worse at times; this has been a constant symptom for several years and varied in intensity. On a number of occasions, she has had to resort to hypodermics for relief. The pain has never been associated with eating or with an empty stomach. For some time, sitting up made the pain worse. She had had no rigors. For the last few months, she had noticed a swelling in the region of the gall bladder which had increased very much since the onset of the acute attack one week ago. There had been more tenderness than usual. She had had no jaundice, distention and no alteration in the bowel function.

The examination showed her to be very frail with a dark, almost bronzed, complexion; she was greatly emaciated. In this report, only the examination will be detailed that has to do with the subject of this paper. The heart and lungs were normal. The upper margin of the liver was one inch higher than normal in the right nipple line and lessened laterally and medially. Below, the liver margin extended about midway to the level of the navel; there was definite bulging in the region of the gall bladder, but the area was much too large for a gall bladder; there was moderate tenderness over the liver and the mass below the rib margin. The liver followed the normal breathing excursions. Otherwise, the examination was not of interest. On admission to the hospital the blood examination showed the white cells to be 5500, polymorphonuclears 56 per cent, and small lymphocytes 44 per cent. The urine was normal except for many pus cells and fine granular casts.

Operation disclosed an abscess of the liver involving a greater part of the right lobe. The fluid was a thin, whitish, pus-like material. The wall of the abscess was very thick and firm. Laboratory examination failed to find any organisms except the usual pus-forming ones. Repeated examinations at later dates were negative for Amoeba histolytica.

This patient had a slow, but normal convalescence. She returned two months after leaving the hospital, suffering from a collection of pus beneath the diaphragm immediately above the liver abscess. This was drained and she made a complete recovery.

CASE III. This patient was a robust, strong day laborer and had never had any serious acute illness. He had never had any diarrheal or dysenteric disease. In 1924, he became very weak, had to stop work and was examined by several different physicians. Finally a diagnosis of low-grade pulmonary tuberculosis was made. He was sent to a sanitorium but the diagnosis was not confirmed. He then ran a long course of low-grade fever during which time he complained of an indefinite pain in the region of the liver and in the right shoulder blade region. He was never able to resume his former labor, but worked at odd jobs between intervals of fever and pain in the upper right abdomen and in the liver region. This continued until two years ago, when he was put in the hospital and treated for ptosis for some weeks. He then complained of pain in the epigastrium, in the right liver region and in the back. He had never been jaundiced. He had been badly constipated and had taken many different laxative medicines for this.

Three months before entering the hospital, he had an attack associated with fever, a dull aching pain in the liver region, nausea and vomiting and occasional rigors. He was in bed three weeks. Later he went back to work, but suffered a relapse with the same symptoms.

On entering the hospital, he gave the following history. For the last three weeks, he had been suffering from a pain in the liver region which radiated backwards through to the angles of the ribs and up into the region of the right shoulder behind. It was almost constant, but never very severe. Eating increased the pain greatly, but gave a measure of relief afterward. He had had profuse sweats recently and had grown much weaker. The bowels had been normal. On admission to the hospital the blood examination showed the white cells to be 29,800, polymorphonuclears 81 per cent, small lymphocytes 19 per cent; red blood cells 4,690,000, hemoglobin 86 per cent. The urine was negative except for a trace of albumin.

DISCUSSION OF CASE REPORTS

These three case histories show that these patients had been suffering from chronic ill health for several years. One of them had been diagnosed as suffering from a gall-bladder condition twelve years before coming in for treatment; another had been chronically ill for eight years and the third for six years. In the course of the illness every patient had consulted several different physicians who had made various diagnoses, but no one diagnosed the illness in the liver or gall-bladder region. At no time was any one of the patients seriously sick, that is, suffering from a serious acute attack. Examination did not disclose any other illness which could explain the condition. No one of these patients had ever suffered from any acute or chronic intestinal disease, such as recurring dysentery or diarrhea. One of them had been habitually constipated; the other two had been constipated at times. There was in no one of these patients any history of any previous illness which would ordinarily suggest an abscess of the liver. In fact, the histories do not disclose any acute infection which might have produced infection of the liver. This would suggest that the infection of the liver began insidiously and progressed very slowly from some minor infection which was never sufficiently acute to produce the usual phenomena of infection. There were periods of comparatively good health when the infection was in abeyance.

All these patients came in for treatment for an acute outbreak of the latent infection; every one of them had had similar

attacks before, but they had not been so severe. Recovery had taken place after a convalescence of varying lengths of time.

DIAGNOSIS

The diagnosis of acute abscess of the liver is generally quite an easy matter as the previous history is suggestive and the immediate history is always that of either an acute bowel complaint or of the dysenteric type, or that of an acute septic process such as suppurative appendicitis, infected gall bladder, ruptured gastric or duodenal ulcer, etc. The infection travels from the septic focus through the blood vessels, the lymphatics or by contiguity and the careful examiner is ever aware of the possibility of a liver infection in such patients.

The diagnosis of chronic abscess of the liver is quite another matter. As a general rule, there is no history of a previous acute infection which might be the forerunner of any liver infection. The history of dysentery, retroperitoneal infection, suppurative appendicitis and similar pathological conditions is usually not present. There is, however, a history of a low state of health which goes back for months or years. The onset is usually indefinite. Some intercurrent infection usually is given as the first notice of failing health. Then, from then on, the patient has a decline, with periods of remission, associated with occasional fever, gastric upsets, obscure and indefinite pain and tenderness in the region of the liver, lower chest, or in the back behind the liver and often pain and tenderness in the right shoulder.

The history shows acute attacks of rather severe or mild pain in the liver region, associated with the usual accompaniments of infection, viz., nausea, vomiting, indigestion, irregular cough, occasional sweats, etc., lasting from a few days to several weeks and ending in a slow recovery to the previous state of subnormal health.

Finally, an acute attack comes on which is more severe than any previous spell and the symptoms are more definite. There is then severe pain in the liver region, fever, tenderness in the

lower chest, limited respiratory movements, distention, etc. These symptoms attract the attention of the examiner to the seat of the infection. The patient becomes emaciated, weak, often slightly jaundiced, has a hacking cough, rapid pulse, indigestion, etc.

The examination shows that the liver is enlarged above and below; it is tender over a rather large area; the tenderness is most acute in some definite area which is the seat of the abscess. This may be difficult to locate especially if it is beneath the upper margin of the liver in either lobe. If it is large and extends downwards to the lower border, or is situated in this region, there may be a well-defined swelling easily recognized. This is not often the case. If in the left lobe, the same signs and symptoms may be present.

The diaphragm on the affected side is often not involved, especially when the abscess is low; but, when the abscess is in the upper border of either lobe, there may be extension to the surface of the liver and even into the subdiaphragmatic space. In such event, the diaphragm will be limited in action and there may be evidence of a collection of pus in this space. Edema of the skin and subcutaneous tissues over the abscess has been noticed and, when present, is a sign of some value. The liver often extends well below the rib margin and when this occurs the abscess may show as a bulging on the liver surface. Or, it may extend upwards and raise the diaphragm and limit the action of the lung. X-ray studies may show the elevated diaphragm and limited lung action, which, if present, is a valuable sign. This sign is present in other conditions than abscess of the liver and it should be taken in conjunction with other and more positive signs of abscess of the liver as a corroborative sign only.

The differential diagnosis[2] between abscess of the liver, subdiaphragmatic abscess and basal pulmonary abscess may be very difficult when the abscess is situated in the upper border of the liver, especially when it is located in the right lobe.

In uncomplicated abscess of the liver, there is no attachment between the liver and the diaphragm. The movements of the diaphragm in respirations are not restricted, but when the liver is attached to the diaphragm, the movements are always limited. The area of dullness is strictly and definitely limited to normal lines when the action of the diaphragm is normal. When the abscess is large and the liver extends upwards, the diaphragm may be quite elevated and the movements somewhat limited. Dullness is not a characteristic of liver abscess; the normal liver dullness is confined to the area of the liver. Auscultation may show restricted breathing, various kinds of rales and other evidences of lung involvement in the lower lobe when the liver is enlarged from any cause. Fixation of the diaphragm is best determined by the *x*-ray when due to adhesions between the liver and the diaphragm.

TREATMENT

Medical Treatment: These patients are always in a state of chronic sepsis. If the diagnosis of abscess is made, the patient may be built up by appropriate treatment for some days before the operation. There is never any emergency and reasonable time for bettering the patient's physical condition should be considered. As a rule, however, these patients rarely come into the hospital except in a severe, acute exacerbation of the ailment.

Surgical Treatment: There are two procedures which merit careful consideration: (1) drainage of the abscess and packing the cavity followed by repeated dressings, and (2) draining or aspirating[3] the abscess and then closing the wound.[4] If pus reaccumulates, aspiration may have to be repeated several times before recovery. There are good surgical reasons for both of these procedures.[5] In the large, solitary abscess with thick walls, aspiration probably is the best method; if the abscess is multiple or the abscess walls are soft and friable, especially if the Amoeba coli is the infecting organism, drainage may be the preferable method of treatment. Statistics are not very

instructive; my experience is not sufficient to base an opinion upon it.[6]

In Case I the patient recovered entirely from the abscess, but died of sepsis five months later. A post-mortem examination showed the liver to be perfectly healed with a very small amount of scar tissue present although the abscess held more than 2000 c.c. of pus. The only organism found at any time was the staphylococcus.

In Case II the patient recovered from the abscess, but later developed a subdiaphragmatic abscess which, after drainage, healed. The staphylococcus was the only organism found in this case.

In Case III the patient had a large solitary abscess which gave a negative culture at first, but later when the pus changed from a pure, thick, whitish pus to a brownish-red the Entamoeba histolytica was found. Nothing that could be done was able to stop the progress of the disease and he died. The operation in all of these patients was simple incision and drainage followed by the use of tube drains and irrigation of the cavities with various solutions. In reviewing the literature, one finds a great difference of opinion among the surgeons with the largest experience as to what is the best method of treatment. My experience is too small to enable one to draw conclusions.

SUMMARY

1. There are reported 3 cases of chronic liver abscess ranging from five to twelve years in duration.

2. None of these patients was known to have suffered from any acute or chronic diarrheal ailments.

3. One patient, after several weeks of drainage, had Amoeba histolytica in the discharge from the wound. The others had only the common organisms of infection.

4. Every patient had suffered from chronic ill health with periods of apparent freedom from disease, but at no time was any one in normal health.

5. One patient died from blood stream infection after the abscess of the liver had healed; one patient had a secondary subdiaphragmatic abscess which healed after drainage.

6. All patients had a simple drainage operation.

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[For Discussion See p. 689.]

ABSCESS OF THE LIVER

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IT is now well known that the term abscess of the liver no longer necessarily suggests the tropics, with their banana shrubs and coconut palms. Boland[1] has reported cases occurring in Atlanta, several hundred miles from the Gulf of Mexico. Lear and Merrill[2] have described an outbreak of amebic disease and abscess of the liver in Connecticut. Sistrunk,[3] in a paper giving the results of a large number of stool examinations made in the Rochester clinic, has shown the wide incidence in this country of protozoal infestation. It is planned in this paper to review about a hundred cases of abscess of the liver recorded in the New Orleans Charity Hospital between the years 1918 and 1932. While the determination of the mortality rate was the principal incentive to bring about this study, other phases of the question have been considered. Subphrenic infections are not included.

The cases reviewed comprise the serial numbers 244–350, including some duplicate numbers, a total of 110 histories; of these 14 were eliminated, 12 because the diagnosis was inadequately established, 2 because of duplication; there remain 96 verified cases. It is interesting to note that one of the cases eliminated (serial No. 349) was found at autopsy to be one of rectal carcinoma with a large metastatic growth in the liver.

Of these 96 patients 58 were discharged and 38 died, a mortality of 39.58 per cent. The 19 cases reported by Boland as a whole had a mortality rate about the same, 42 per cent. Herrick's 47 cases in the Canal Zone[4] showed 11 deaths, a low mortality rate of 23.4 per cent. Touro Infirmary in New Orleans has records of 48 cases with 18 deaths, a mortality rate of 37.5 per cent.

Comparison was made on the basis of parasites found. Counting as amebic the cases in which smear and culture were negative (47) with those in which the pus (2) or the feces (7) showed ameba, a total of 56 cases was arrived at with 19 deaths, a mortality rate of 33.9 per cent, about the same as that of Boland's 14 amebic cases with 35.7 per cent; the cases showing staphylococcus, streptococcus or Bacillus coli infection gave a mortality of 37.9 per cent, as against Boland's 60 per cent, due to 3 cases of multiple abscess, necessarily fatal. Herrick's 47 cases, with a 23.4 per cent mortality, reported in 1910, were probably all amebic.

Cases noted as having large abscesses showed 26 recoveries and 14 deaths, a mortality of 35 per cent, a little below the general rate of 39.58 per cent.

In an endeavor to find comfort somehow and somewhere in the face of this heavy mortality rate, the 96 cases were divided into two equal halves, serial numbers 244–296, from 1918 to 1925 inclusive, 299–350 from 1926 to 1931 inclusive. It was hoped that the proportion of fatal cases would be found less in the latter half because of better diagnostic means including *x*-ray pictures of the thorax with tell-tale elevation of the right leaf of the diaphragm in liver pathology. The result of this comparison was that the first 48 showed a mortality of 35.4 per cent, the second group 43.7 per cent.

Some little comfort was derived from the comparative mortality in whites and blacks, the former showing a 30.1 per cent rate, the latter 51.1 per cent, probably as a result of greater delay in seeking treatment.

In this connection the comparative incidence in whites and blacks was studied. In our series of 96 patients 55.2 per cent were whites, 44.8 per cent blacks. The Hospital admissions for the years 1919–1931, inclusive, were 195,840 whites, 154,206 blacks, in the proportion of 55.9 per cent whites, 44.1 per cent blacks, about the same as the proportion in our 96 cases, showing no greater incidence in either race.

Examining other phases of the records it was found that 2 cases gave a history of trauma; 33 out of 96 gave a history of diarrhea of importance, recent or old. Six were jaundiced on admission.

It is of interest to note that in 47 cases (72 per cent) the *x*-ray picture showed a high right leaf of the diaphragm, while in 18 cases (28 per cent) this diagnostic aid was absent. In 60 cases (80 per cent) there was a definite leucocytosis, in fifteen (20 per cent) no leucocytosis.

One patient reported ten years spent in the tropics; two were steamship firemen, one of whom reported a stay in the tropics, while another very likely had been similarly exposed. Aside from these cases occupation and residence had no perceptible influence.

Three were recurrent cases, a previous operation having shown abscess of the liver.

The relative proportion of male and female patients was such as to attract attention, being 92.8 per cent males, 7.2 per cent females. Doctor C. C. Bass of New Orleans, in an oral communication, informs me that in a large number of stool examinations for ameba he has rarely found this parasite in female patients. It is suggested that the occupations of women, which confine them more to the home and its safer food and drink, protect them from the dangers incurred by men who do more eating and drinking away from home, besides indulging in injurious habits not as yet widely cultivated by the opposite sex. Alcohol may be a factor of importance.

Investigating the thoracic complications, to which attention was drawn by Thompson,[5] 3 cases were found recorded as showing involvement of the right pleural cavity, one with bronchohepatic fistula; a fifth came in with hemoptysis. Of these 5, 4 died, a mortality of 80 per cent.

The 38 fatal cases yielded 12 autopsies. In 5 cases multiple abscesses were found; in 2 cases free blood was found in the abdomen (200 c.c. and 1500 c.c. respectively); in 3 there was pneumonia and in 2 there was nothing noteworthy besides the

single abscess. In one of the 3 pneumonia cases there was rupture into the pleural cavity; in another pneumonia case there was perforation into the colon. No case presented cerebral or splenic abscess.

The details of one of the multiple abscess cases may be of interest.

> This was a boy of fourteen (serial No. 299), who was operated on by me on December 3, 1925; under ethylene anesthesia an acutely inflamed appendix was removed; there was a considerable amount of clear fluid in the cavity; the wound was closed without drainage. After operation the temperature rose, the liver became large; aspiration brought pus which showed streptococci in smear and culture. There were no chills. On December 8, five days after the appendectomy, an abscess of the liver was drained after rib resection and packed with gauze; on January 7, another abscess was opened through the midline under local anesthesia; death occurred on January 8. Autopsy showed an abscess at the site of the appendectomy, and multiple metastatic abscesses of the liver and kidneys.

Methods of treatment were compared. The most common was incision of the abscess, after adhesions were made sure of, and packing the cavity tight with iodoform gauze soaked in balsam of Peru and castor oil. This method in New Orleans is attributed to Rudolph Matas. Twenty-three cases were recorded as treated by this method, with a mortality of 5, or 17.8 per cent. The next most popular method was incision and drainage with tubes only; this was applied in 17 cases with 5 deaths, 29.4 per cent. Cases drained by a combination of tubes and gauze packing were eliminated. Other methods employed were (a) closed drainage with trocar and tube, (b) the Nather-Ochsner[6] technique of posterior approach, and (c) aspiration followed by injection of anayodin. The cases treated by these methods were too few to permit of satisfactory comparison from the mortality viewpoint.

COMMENT

The importance of the liver in bodily functions, its relation to abdomen and chest, make hepatic abscess a disease of prime

importance. The mortality rate in all hands is heavy. What can be done about it? First of all must come prevention and cure of the infections preceding it. Preventive medicine must ward off infestation of the human bowel with Entameba histolytica. Diarrheas of any duration must be investigated and given proper treatment. The barium enema is a recent addition to the diagnostic technique, showing small ulcerated areas. Inflamed appendices must be removed promptly to anticipate pylephlebitis. As surgeons we are interested in early diagnosis and effective treatment. Diagnosis is based on enlarged and tender liver, usually attended with fever and leucocytosis; there may be chills, jaundice, pain in the shoulder, a history of antecedent diarrhea or dysentery. X-ray films show an elevated right leaf of the diaphragm, with the angles clear. Considerable difference of opinion exists as to exploratory puncture. Thompson,[5] Lear and Merrill,[2] and Wilmoth[7] recommend the systematic exploration of the liver with needles reaching a depth up to 4 inches. Wilmoth supplements the use of the needle with shadow-casting media to show the exact location and extent of the abscess. On the other hand Herrick[4] with a considerable experience in the Canal Zone describes localization by the needle as unreliable, speaks of fatalities reported from its use, and recommends laparotomy in all cases where doubt exists as to the location of the abscess and in all cases where the symptom complex is not explained by disease elsewhere. It would seem that here as elsewhere the truth lies between the extremes. When suspicion points to easily accessible regions like the epigastrium or the right infracostal region, it is easy and safe to explore with a needle; where the needle fails in the face of strong suspicion a laparotomy will be helpful. We are warned against the danger of hemorrhage from puncture of an acutely inflamed and excessively hyperemic liver. If the region suspected is high and posterior the Nather-Ochsner method of exploration by resection of the right twelfth rib and approach between the diaphragm and the peritoneum offers a practical and satisfactory technique.

Relative to treatment also there is room for difference of opinion. While incision and a tight pack to distend every pocket gave the best results in our series, I am deeply impressed by the figures for amebic abscess given by the British Army surgeon in India, Sir Leonard Rogers.[8] He reports 2661 cases treated by open operation between 1893 and 1907 with 1311 deaths, a 56.7 per cent mortality. After the change from open operation to aspiration, followed at the beginning of the series by washing out with 1:500 quinine sulphate solution and later by emetine hypodermatically without irrigation, 111 cases gave 16 deaths, 14.4 per cent mortality. A pupil of Rogers, K. K. Chathrji is quoted[9] by him as reporting 186 liver abscesses treated by aspiration and emetine, combined with irrigation of the cavity through the aspirating needle, with a remarkably low mortality of 1.6 per cent. Rogers states that 86 per cent of abscesses were sterile when opened; operation led to secondary infection as in tuberculous abscesses. The experience of Lear and Merrill in Connecticut confirmed the value of the aspiration-emetine method.

It may well be that the best results from treatment will be obtained by careful study of the patient with reference to parasites in pus and in bowel, so as to differentiate bacillary from amebic abscess, the latter to be treated with aspiration, emetine and anayodin, with or without irrigation, the former by incision and full packing.

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DISCUSSION ON PAPERS OF DRS. BOLAND, AYNESWORTH AND GESSNER

Dr. Rudolph Matas, New Orleans, La.: Abscess of the liver is a subject of perennial interest in New Orleans and Louisiana where amebiasis and amebic dysentery prevail and at times, in the past, epidemically. Dr. Gessner has admirably presented the situation in New Orleans as this is reflected in the experience of the Charity Hospital and in our private practice.

Owing to the relative frequency and gravity of amebic abscess, I have devoted much time and labor to its statistical study and from this and my personal experience I may be able to supplement and stress some of his remarks.

A point, I think, of much importance is that there has been a steady decline in the incidence of hospital abscess as a complication of amebic dysentery in the course of the last two decades. Thus in the decennium 1884–1894, the decennial incidence of hospital abscess at the Charity Hospital in relation to the total hospital population was 29 in 10,000 of the white and 27 in 10,000 of the colored population, with a mortality of 43.08 per cent for the white and 59.62 per cent of the colored. On the other hand, during the decennium 1914–1924, the decennial incidence to hospital population was 7 in 10,000 white and 3 in 10,000 colored with a mortality of 28.5 per cent white and 32.5 per cent colored.

During the period 1884–1909 (twenty-five years) a total of 536 cases of abscess of the liver were treated in the hospital with an average general mortality of 40 per cent. The average incidence per annum during the twenty-six years was 22.3 cases.

During the decade 1914–1924 (202 cases) there was a progressive diminution in the annual admissions for abscess of the liver, from 42 cases with 8 deaths in 1914 to 6 cases without a death in 1920. Since 1920, the population of the Hospital has greatly increased but the incidence of hepatic abscess has not increased; to what extent it has decreased in proportion to the total admissions, I am not prepared to state from accurate statistical figures. If I may judge by my personal experience and my opportunities for observation, amebic abscess of the liver has now become a relatively rare complication of amebic dysentery in comparison with its frequency up to 1914 when as many as 42 cases were admitted to the Hospital.

How can we account for this remarkable diminution in the prevalence of abscess of the liver? The only way that I can explain this decrease is by the vastly superior methods of recognizing the amebic infections and by the more efficient modes of treatment in their early stages. It may be safely stated that 80 per cent of the cases of abscess of the liver of the common solitary, tropical type are due to colonic amebic infections. The improvement of our statistics both as to incidence and mortality has coincided with the generalized use of emetine as a specific for amebic infections since Leonard Rogers had popularized its use in dysentery, in 1912, and Chauffard in France had demonstrated its specific value in controlling and often aborting abscess of the liver. The therapy of the amebic infections has been further improved by other later successors of emetine and in this way the prevalence of the chronic types of amebic dysentery, which were the most frequent causes of these abscesses fifteen years ago, has enormously diminished.

I have a record of 79 cases of abscess of the liver that have come under my personal care. A number of these patients have come from the central American countries. The mortality in the earlier years was about 40 per cent. After 1898, it gradually decreased until in later years it fell to 13 and 10 per cent. This improvement I attribute to the early diagnosis of the primary colonic infection and its better treatment, to the better type of patients who are no longer of the chronic cachectic and marasmic type that was so frequent on the pre-emetine period, and to the immense benefit of the specific anti-amebic medication with emetine which has sufficed in several cases to cure the abscess with the aid of simple and repeated aspiration.

Dr. Lloyd Noland, Birmingham, Ala.: Doctor Gessner has quoted Doctor A. B. Herrick of Panama as having presented the best results in many years. I was on the Panama Canal work for nearly nine years, part of which time I was fortunate enough to be first assistant to Doctor Herrick. I believe that Herrick's results were largely due to the fact that he abandoned exploratory aspiration of the liver transpleurally far earlier than did most surgeons. He gave up aspiration largely because of two complications; first, because of the number of secondary pleural infections following leakage from abscesses into the pleural cavity, and second, because of the fact that in many cases multiple abscesses were missed. His adoption of an exploratory laparotomy with careful palpation of the entire liver, was, I think, a distinct advance. He was able to demonstrate immediately the exact location of either single or multiple abscesses. It was then a simple matter to close the abdomen and to approach the abscess accurately if it were in the dome of the liver. I believe that his method of handling the pleura in dome drainage cases had much to do with his excellent end results. He early gave

up any attempt to suture the pleura, and instead of this he went through the diaphragm, making a fairly free incision, grasped the edges of this diaphragm incision and brought them up for suture to the intercostal muscles before the abscess was opened. In this way he got a funnel-shaped drainage with complete occlusion of the pleural cavity. I am firmly convinced that exploratory aspiration of the liver in suspected cases of abscess is a dangerous and unwarranted procedure in the majority of cases.

Dr. George H. Hendon, Louisville, Ky.: I wish particularly to address my remarks to the papers of Dr. Boland and Dr. Aynesworth. It is quite surprising and almost incredible to note the amount of good we can do preoperatively if we treat the patients with the continuous intravenous glucose, the idea of which originated with Dr. Matas. I have taken a great deal of pains to simplify its application and make it easy to use. If we discontinue all foods, allowing no nutrition by the stomach or intestine, and feed these patients for four or five days in this manner the case will become very much simplified. The symptoms that are by-products of the disease will gradually disappear and place one in a better position to approach the case surgically. In a case I saw recently there was a large tumor in the epigastric region which was diagnosed as a retention cyst of the pancreas. The patient was in bad condition, vomiting and so on, and this treatment was adopted for the purpose of relieving the vomiting. The result was that the large tumor gradually subsided, conditions arranged themselves in a more normal manner, and then it was found that the patient was suffering with gallstones. I know of cases of small punctate abscess of the liver that were entirely cured by this method. I operated on one patient with the idea that he had an empyema of the gall bladder, but at operation found that the liver was covered by these small suppurative areas. He had subsequent pain, three or four months later, and I operated again and removed the gall bladder.

It seems that by feeding individuals in this way we relieve the liver of part of its burden.

Dr. Frank K. Boland (*Closing*): I have used Dr. Hendon's method of continued venoclysis in some of these cases with great satisfaction.

I have nothing more to say about suppurative cholangitis except that the condition is very rare. In the Grady Hospital over a period of ten years only one case was so diagnosed.

We have had 20 cases of abscess of the liver during this time, 15 amebic and 5 traumatic. In the 15 cases we have demonstrated amebae in the wall of the abscess in 12 cases and in the remaining 3 the history and signs were so typical that the diagnosis seemed warranted. In only 3 cases did we find amebae in the stools. It is very difficult to find the plasmodium in the stools, but we did find these parasites in the walls of the abscess. As Dr. Gessner

mentioned, in most of the cases of abscess of the liver the enlargement is upward. We have found that true in every case and it may be of value as a diagnostic sign. There is marked enlargement upward with elevation of the diaphragm. In cancer of the liver the enlargement is downward, with no elevation of the diaphragm on the affected side. In the *x*-ray study of these cases this is of importance.

One of the differential signs between the Ameba coli, which is commonly found in the stools, and Ameba histolytica is that the Amebae histolyticae destroy the red blood corpuscles, and the Amebae coli do not.

DR. H. B. GESSNER (*Closing*): Dr. Matas brought out a very interesting point in mentioning the decrease in the incidence of abscess of the liver. During the years 1926–1931 there was a great increase in the hospital admissions, yet we had the same number of liver abscesses as in the period from 1919–1925 despite this marked increase of admissions.

I can recall one case in which puncture of an abscess of the liver was followed by hemorrhage which was the cause of death. For some reason these livers in the early stage of abscess are very hyperemic; they bleed a great deal when punctured.

I think most of us would hesitate to open the abdomen in a patient who was ill for the purpose of exploration of the liver. In some cases if you suspect abscess and your needle puncture fails it might be justifiable. I think this has to be settled for each individual case.

MÉNIÈRE'S DISEASE: DIAGNOSIS AND TREATMENT

REPORT OF THIRTY CASES

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I MIGHT preface my remarks by two general statements concerning Ménière's disease:

1. It is easy to diagnose and the diagnosis is unmistakable.

2. It can be permanently cured and at practically no risk to life or function.

In 1928 a preliminary report was made upon the operative results on 9 patients afflicted with Ménière's disease. A total of 30 patients who have been operated upon forms the basis of this report.

In 1861 Ménière, a Frenchman, described a syndrome which remains practically unchanged today. The story of Ménière's disease is much like this: A patient who is perfectly well in every respect, suddenly, without warning and without apparent cause, is seized with a terrific dizzy spell, lasting for many minutes, sometimes hours or even days. The dizzy spell passes off and the patient is again perfectly normal until at a later time a similar attack develops, and again without warning. From that time on, life is a succession of just such attacks occurring at varying intervals of time. Associated with the attacks there is usually vomiting and nausea. And most important of all there is almost always tinnitus and always subtotal deafness, and both are in the same ear.

Ménière's disease, therefore, is a series of attacks of terrific dizziness, nausea, vomiting and tinnitus, grafted upon unilateral defective hearing. The deafness is progressive.

A mistake in our conception about Ménière's description of the pathology of Ménière's disease should be noted. As a matter of fact he had never seen an autopsy of a case of true

Ménière's disease. He did make a pathological report of a very dissimilar clinical condition, namely, acute labyrinthitis; and he described, as one might expect, the course of purulent and

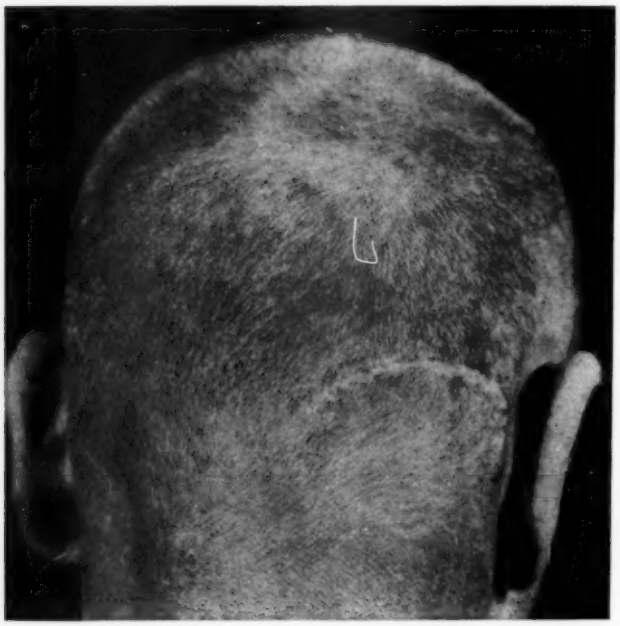

FIG. 1. Scar of author's operation for Ménière's disease.

hemorrhagic exudate in the labyrinth. That, of course, was before the development of bacteriology. At the present time most textbooks carry the statement that Ménière's disease is due to a hemorrhage in the internal ear. But, as I shall explain, Ménière's disease has probably nothing to do with the inner ear. It is merely an explosion of the function of the inner ear and is due to a lesion of the auditory nerve.

There are two conditions which may be confused with Ménière's disease in differential diagnosis: one, pseudo-Ménière's attacks, perhaps quite seriously; and the other, cerebellopontine tumor, only superficially. In the former the symptoms are much alike but the signs dissimilar; in the latter the signs are quite similar but the symptoms are never the same.

In pseudo-Ménière's disease the attacks are exactly like those of Ménière's disease, but there is never unilateral

deafness. These attacks come on without any change in hearing and upon this distinction alone one can make the differential diagnosis which, of course, is an all important one where

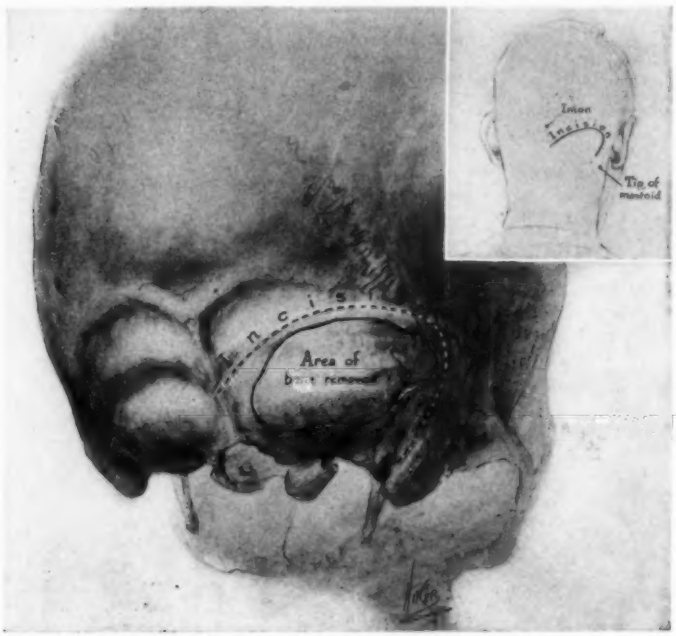

FIG. 2. Line of incision, size and position of bony defect for approach to sensory root of eighth nerve.

therapy is considered. The other condition is a cerebello-pontine tumor. Objectively there are two findings (often only one) in Ménière's disease, both are referable to the acoustic nerve. One is a reduction in hearing, but the deafness is not total; the other is a diminished caloric response. When the ear is irrigated with hot or cold water there may be a diminished thermic response. However, only about half of our cases give such a change. In many instances, therefore, the objective signs of Ménière's disease are referable to both the acoustic and the vestibular divisions of the eighth nerve. It happens that these are the objective signs that obtain in the early cases of acoustic tumors. But the resemblance between Ménière's disease and acoustic tumors ends there, for although there is a gradual loss of hearing from acoustic tumors they never

cause the attacks of dizziness that characterize Ménière's disease.

Ménière's disease has run the gamut of varied forms of

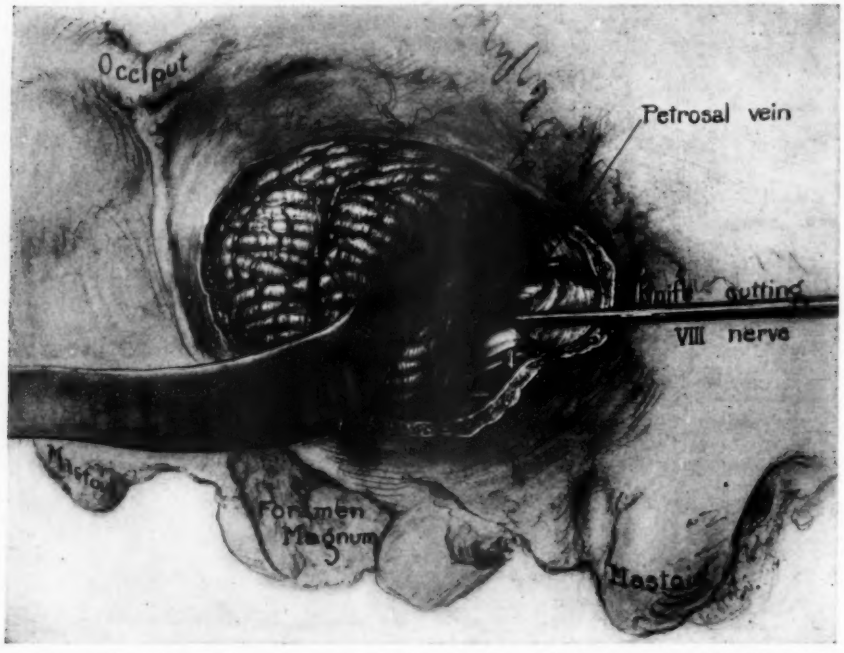

FIG. 3. Operative sketch showing method of sectioning eighth nerve for Ménière's disease.

treatment; practically everything has been suggested. As a matter of fact, nothing has been of the slightest benefit until the recent advent of the operation of which I shall speak briefly.

The great Charcot who was a contemporary of Ménière was very much interested in this condition and made the very astute observation that if a patient became stone deaf in the affected ear (an unusual occurrence) the attacks ceased. At that time Charcot suggested (and that was before the dawn of aseptic surgery) that perhaps at some time in the future surgery would develop to such a point that it might be possible to divide the eighth nerve and cure Ménière's disease. Charcot's suggestion is the treatment of Ménière's disease today.

We have now had 30 cases in which the nerve has been sectioned intracranially, and in not a single case (and some of

our cases now have gone over a period of about six years) has there been a single subsequent attack resembling Ménière's disease in any patient. It really offers an almost perfect cure because the patient loses nothing by section of the auditory nerve, except the remains of hearing which are of no practical value.

The treatment entails practically no risk. There has been no fatality, and there have been no after effects, except in two of the early cases when the facial nerve was injured. That will not happen again. The facial nerve lies in very close apposition to the eighth nerve, but it is now a very simple matter to separate them and to avoid injury to the former.

We know the pathology, we do not know the etiology, but just as in trigeminal neuralgia, we have learned that the disease may be permanently cured and without subsequent attacks, by section of the ventral root of that nerve.

Just a word about the etiology and pathology of Ménière's disease. We know of no cause for Ménière's disease. Certainly there is no infection. Never does Ménière's disease follow infections of the middle ear. And so far as we have been able to learn from our series of cases, there has been no focal or systemic infection to which this condition might be ascribed. So far as I know a necropsy of a case of Ménière's disease has never been reported.

However, this point seems clear in regard to the pathology of Ménière's disease: We know (1) that the acoustic division of the auditory nerve is affected because of the loss of hearing, and that (2) the vestibular branch is affected because of the diminished caloric response. It is necessary to assume, therefore, that we are dealing with a lesion not in the middle ear, nor in the inner ear, but rather in the auditory nerve. A lesion of the inner ear could not affect both the acoustic and auditory divisions of the eighth nerve.

We believe the attacks of Ménière's disease are precisely similar to the *paroxysmal* attacks in trigeminal and glossopharyngeal neuralgia. For reasons that have been advanced

elsewhere we believe that the cause of trigeminal neuralgia is always in the sensory root of the nerve. And for the reasons mentioned above we think there is ample proof that the lesion of Ménière's disease lies in the sensory root of the auditory nerve.

DISCUSSION

Dr. Claude C. Coleman, Richmond, Va.: A great deal has been known about Ménière's syndrome since about 1861, but there was no successful treatment of the condition until 1928, when Dr. Dandy proposed a clear-cut surgical Ménière's syndrome, for which he advocated intracranial section of the auditory nerve on the affected side. At that time Dr. Dandy published a report on 9 cases which had been relieved by this operation. Since Dr. Dandy's report, we have operated upon 12 cases by his technique, with perfectly satisfactory results in every case so far as the vertigo was concerned. Tinnitus has not been entirely abolished in every case, but if not abolished, it has been improved.

While a few isolated attempts had been made to relieve vertigo by division of the auditory nerve, the credit for placing the syndrome upon a sound surgical basis is due to Dr. Dandy. He has referred in his paper to the similarity of Ménière's disease to tic douloureux, and this similarity impresses itself upon anyone who has had experience with the surgical treatment of both diseases. The attacks in both conditions are of paroxysmal and explosive character. The operation in neither carries more than a negligible risk, and altogether the operation for either tic douloureux or Ménière's disease is one of the most successful in cranial surgery.

In the 12 cases in our series we have had no bad results, except a temporary facial paralysis in two. Both of these patients recovered from the facial paralysis in a short time. The operation is done satisfactorily under local anesthesia, supplemented by some such drug as morphine or hyoscine. There is every reason to believe that the operation will become more and more used, because of its satisfactory results, and because there are a considerable number of such cases. It might seem on first thought that the operation is a formidable procedure, and might cause some patients to hesitate because of the total deafness on one side produced by the operation. Paradoxical as it may seem, our patients generally stated that they heard better following operation than before, due to the fact that the disturbing tinnitus was either removed or very considerably improved.

SURGICAL TREATMENT OF TRIGEMINAL NEURALGIA

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SURPRISINGLY accurate descriptions of trigeminal neuralgia have been in medical literature for many years, in spite of the fact that the essential nature of the disease is a mystery. Its etiology and pathology are unknown, yet it presents a clear-cut clinical syndrome. The victims of it are usually past middle life, although it is occasionally seen in the third and even the second decade of life. In the experience of the author women are more frequently affected than men. Hypertension is common, and every surgeon who attempts to expose the ganglion knows what a lost, brittle meningeal artery means in such cases. The relationship of high blood pressure and of arteriosclerosis to the genesis of the pain itself deserves further study. Dr. Joseph Hirsh of Birmingham has recently reported to the writer a case in which he was treating asthma in a patient who also suffered from typical migraine. On four occasions he injected 0.5 c.c. of 1:1000 solution of epinephrine to control the asthmatic spasms. Immediately typical tic-like paroxysms of pain occurred in one supraorbital nerve, and morphine was required to relieve them. Blood pressure determinations were not made at the time.

SYMPTOMATOLOGY

Tic douloureux is a disease of the fifth cranial nerve, and its only symptom is pain in the peripheral fields of this nerve. This pain is typically paroxysmal in character and occurs most frequently in the zone of the third division of the nerve, next in the second, and least often in the first. It is often initiated by some irritation in a particular spot known as a

"trigger zone." Such stimulation may be caused by shaving, by food or drink, either hot or cold, or even by speaking. The pain is explosive, lightening like and shoots upward along the line of the nerve trunk often to overflow into an adjacent field. These paroxysms of pain may be accompanied by vasomotor phenomena, the face may be drawn toward the affected side, a curious chewing motion is often seen, and the patient frequently holds the painful region tightly in his hand. These paroxysms may recur frequently, usually there is no pain between the attacks, and the paroxysms do not often occur at night. Morphine does not relieve them and, for this reason, addiction is not the rule in this disease. The pain is excruciating and is probably as terrible as any pain to which human flesh is heir.

These typical attacks of pain must be differentiated from other clinical syndromes, chief of which is that form of neuralgia known as lower hemicranial neuralgia, or Sluder's neuralgia. In 1908 Sluder[1] described "lower half headache," consisting of pain about the eye, the upper jaw and the teeth, with earache and pain in the mastoid, with a tender point about 5 cm. behind it. The pain also extends to the occiput, neck, shoulder, scapula, arm, forearm, hand and fingers. Sluder showed that this disease is probable often caused by sinus infection and may be relieved by cocainization of Meckel's ganglion. Permanent relief is to be expected from removal of the local foci.

Recently Vail,[2] of Cincinnati, has described an analogous neuralgia in which the Vidian nerve is involved.

There is also the fairly well-known tic of the glossopharyngeal nerve in which the pain is similar in type to true tic douloureux, but is even more terrible, if that be possible. Five recent cases have called attention to the frequency of neuralgia involving the ascending branches of the upper

[1] SLUDER, G. The role of the sphenopalatine (Meckel's) ganglion in nasal headache. *N. York M. J.*, 87: 989, 1908.

[2] VAIL, H. H. Vidian neuralgia. *Ann. Otol., Rhinol. & Laryngol.*, 41: 837, 1932.

cervical nerves. In these cases the pain was unilateral and followed the distribution of the occipital and posterior auricular nerves, and could at once be relieved by a novocaine barrage extending from the posterior occipital protuberance to the mastoid tip. Division of all ascending branches between these two points was done for two patients. Complete relief was afforded and will undoubtedly continue until regeneration of these nerves takes place. A hypertrophic cervical arthritis is a probable cause of this type of pain.

TREATMENT

Futile attempts to relieve the pain of true neuralgia are often made by removing foci of infection in mouth, antra and sinuses, so often, in fact, that few patients reach the neurosurgeon with their own teeth or with intact accessory sinuses. The author has seen no patients relieved by these operations, and has personal knowledge of only one whose pain in the third division was reported to have been cured by the removal of a molar tooth with a bulbous root impinging upon the nerve in the dental canal.

In a consideration of treatment, it must be remembered that relief of pain is accomplished at the price of anesthesia. Dandy, however, has reported several cases in which he was able to relieve pain by partial section of the sensory root as it lay alongside the pons, with retention of cutaneous sensibility. He has perfected his cerebellar approach until he is able to accomplish the section in a fraction of the time usually consumed in the transtemporal operation, and he reports few complications. The cerebellar approach, however, is not to be chosen by one unskilled in posterior fossa surgery.

Permanent or temporary relief may be offered to patients suffering from tic douloureux. Permanent relief is possible by a highly perfected operation upon the sensory root of the nerve, or by the sometimes successful, even though ill-advised injections of alcohol into the ganglion itself. Temporary relief may be offered with comparative safety by alcoholic

injections into the second and third divisions as they emerge from the skull, or by peripheral injections or neurectomies of the terminal branches of the nerve. Alcoholic injections into the second and third divisions are useful in affording relief lasting often for a year or more, and have the great value of making it possible for the patient to evaluate the resulting anesthesia, and to choose between his former pain and his present anesthesia. In cases of false neuralgia, the patient is apt to rebel over the "wooden face," while in true neuralgia, he gratefully accepts permanent loss of sensation even over the entire half of his face in lieu of his previous unbearable torture. So where the diagnosis is in doubt it may be wise to give the patient the opportunity to choose between pain and anesthesia during the period of nerve regeneration.

The injection into the second division is made either under the zygomatic arch into the sphenopalatine fossa to reach the nerve as it emerges from the foramen rotundum, or from inside the mouth, according to nerve block methods familiar to oral surgeons.

The third division is reached as it emerges from the foramen ovale either by a lateral approach traversing the temporal fossa under the zygoma, or from an anterior approach, the needle closely hugging the lateral aspect of the maxilla just above the alveolar process.

These peripheral injections in skilled hands are relatively free from danger, even though tragic injury to eustachian tube and optic nerve has been reported. The writer wishes to warn against any attempt to introduce the needle into the foramen ovale and to inject the ganglion itself. Successful alcoholic injections of the ganglion afford permanent relief, but are accompanied by such risk to the central nervous system and to adjacent structures that they are not to be considered.

Peripheral neurectomy is now confined to the supraorbital nerve. The scar of the incision is in the line of the eyebrow and is soon covered; the nerve is easily exposed, and complete

resection of its trunk accomplished. Pain in the infraorbital nerve is controlled by alcoholic injection of its foramen, while the inferior dental is injected peripherally through the mental foramen or as it enters the inferior dental foramen on the buccal surface of the ramus of the mandible. These injections have the advantage of being relatively easy and safe; they afford great relief, and they give the patient choice of anesthesia or pain. Sensation returns in from three months to several years, and along with it pain. Subsequent injections are usually less satisfactory and afford shorter relief.

The modern radical operation for tic douloureux is a therapeutic triumph and illustrates the mastery of physiology, anatomy, and of surgical technique, which alone has made intracranial surgery possible. Removal of the ganglion was first proposed by J. Ewing Mears in 1884, and was first successfully accomplished by E. Rose six years later. Operations upon the ganglion, and upon its second and third divisions distal to the ganglion, were done until Spiller in 1899 made the brilliant suggestion that permanent relief would be afforded by section of the sensory root proximal to the ganglion. Frazier was the first to seize upon this suggestion and to utilize the physiologic fact that sensory nerve fibers cut between the ganglion and the brain would never regenerate, and it was he who was first to cut the sensory root of the ganglion. To him is due the credit for the saving of the motor root, and the partial section of the sensory root which now makes possible a selective anesthesia. In other words, it is now possible to divide only those fibers of the nerve which transmit pain stimuli, and to cause the minimum of cutaneous anesthesia. Fortunately, the first division is seldom involved and it is now no longer necessary to cause anesthesia of the cornea, with the large incidence of corneal ulcers following therefrom.

The radical operation has been so systematized that it has become relatively a simple procedure. The author has done the sub-total section of the sensory root in Birmingham

37 times without a death, and with permanent cure in all cases. One patient had a return of pain, and it was necessary to cut additional fibers eighteen months after the first operation. The re-exposure was easy, no trouble was experienced from hemorrhage, the uncut fibers were easily identified, and permanent relief followed their section.

TECHNIQUE

A basal anesthesia with local infiltration is now being used. Avertin, in recent cases, has been very satisfactory. A vertical incision as in the classic Cushing sub-temporal decompression is done, the muscles are retracted and elevated with special retractors and an opening is made with perforator and burr just above and in front of the zygomatic root. This is enlarged with rongeurs until an oval defect from 3 to 4 cm. in size extending below to the floor of the middle fossa is obtained. The dura is now gently elevated and the groove made by the middle meningeal artery is sought. This is followed with a seeker toward the foramen spinosum which transmits the artery. The foramen is carefully plugged with a bit of cotton packed tightly in with an angular dental cavity probe, and the artery divided. It is usually unnecessary to tie the distal end. (Dental instruments of various shapes and sizes as well as cotton sheets and rolls and pledgets prepared for the dentists are all very useful.) The dura is continuously elevated with an electric lighted retractor and the foramen ovale is sought mesialward and forward from the foramen spinosum. As soon as the fibers of the third division are seen, the nerve trunk is distended with novocaine epinephrine solution. The ganglion is also infiltrated, and an incision is made longitudinally along the lateral margin of the ganglion, dividing the dural sheath. This incision is in line with the fibers of the third division, it opens up the dural pocket enclosing the ganglion, and allows the dura to be stripped back, uncovering the ganglion. As the sensory root comes into view, and is uncovered backward, there is a gush

of cerebrospinal fluid from the posterior fossa. This escape of fluid is helpful, as it decreases the intracranial volume, makes retraction of the temporal lobe easier, and hemorrhage becomes less troublesome. It must be adequately controlled, however, so as to admit of clear exposure of the ganglion and of the sensory root. Bleeding is perhaps less with the patient in an upright position, but the writer is accustomed to operate with the patient lying upon an inclined table.

The motor root runs beneath the sensory root obliquely from above downward and outward; it lies entirely free and passes beneath the ganglion to blend with the third division before it enters the foramen ovale. It is possible to elevate the sensory ribbon-like root from the underlying small cord-like motor root and to divide as much of the sensory root as is desired without injury to the motor root.

The fibers of the third division lie below and lateralward, those of the second next, and those of the first division highest and medialward in the sensory bundle. It is possible to produce anesthesia and to afford relief of pain in any of these fields by differential section of the fibers in the sensory bundle.

It is of vital importance to retain sensation in the cornea, so in all cases where the neuralgia does not involve the first division, the upper medial fibers of the sensory root should be conserved. Objection has been made that the neuralgia might recur in the first division. This actually happened once in the writer's experience and a second operation was necessary. Deep venous bleeding is usually controllable with pieces of muscle. Only once has it seemed wise for the writer to leave in a drain. The wound is closed in layers, and the eye lids sutured temporarily.

In this series of 37 radical operations there has been no death. In 2 patients there was a temporary weakness of the external rectus. In one there was a complete facial palsy beginning the seventh day after operation, and gradually becoming complete. The explanation of this paralysis of the seventh nerve lies in the possibility of trauma transmitted

from the gasserian ganglion through the great superficial petrosal nerve to the ganglion of the knee of the seventh. At this point this nerve lies in a bony canal, and slight trauma might cause sufficient edema of the nerve to cause its interruption in its bony canal. In this particular case, power in the orbicularis was lost, and a colleague, Dr. Frank Clements, kindly did a partial tarsorrhaphy to protect the exposed cornea. In this procedure temporary synechiae were formed between the edges of the upper and lower lids. Full power returned within a year, the lids were separated, and the patient has remained well without any injury to the eye.

TRICHLORETHYLENE

During the war workers in Germany using trichlorethylene were found to show anesthesia of the fifth nerve. This chemical is now being used as treatment by inhalation. It has a selective action upon the sensory part of this nerve. Twenty to 30 drops three times a day are inhaled from a handkerchief by the patient while reclining. Relief may be afforded in a few days. If it is not experienced in four or five weeks, the treatment is discontinued.

SUMMARY

1. Tic douloureux is a definite disease of unknown etiology without known pathology.

2. It must be differentiated from other neuralgias which affect the sympathetic nervous system.

3. Palliative neurectomies or alcohol injections affording temporary relief may be wise.

4. Radial operation is safer than alcoholic injection of the ganglion.

5. The radical operation is relatively free from risk, and affords certainty of relief with little danger of injury to other structures.

6. Trichlorethylene may prove so useful that operation may become unnecessary in many cases.

CHRONIC PRIMARY TUBERCULOSIS OF THE SPLEEN

X-RAY DIAGNOSIS; CASE REPORTS

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JACKSON, MISS.

SECONDARY tuberculosis of the spleen coincident with tuberculous involvement of other organs in the body is of rather common occurrence. This association especially occurs in children.

The term primary in this connection does not imply that the original focus of infection necessarily occurred in the spleen, but that there the disease became localized, while the point of entry either did not develop gross pathology or healed without leaving evidence of active disease. The lesion in the spleen develops and runs usually a chronic course, causing symptoms of general toxemia and local inflammation. From it bacilli may be disseminated.

Winternitz[1] presented a full and authoritative description of primary tuberculosis of the spleen, reporting one case of his own and collecting and summarizing 50 cases to be found in the literature. Thirty-four of these cases were discovered at autopsy, the remaining 17 at operation. Of these 17 cases on which splenectomy was performed, 10 recovered. Since 1912 some 20 or 30 additional cases have been reported.

Price and Jardine[2] state:

> There is no characteristic symptomatology which would aid one in distinguishing primary tuberculosis of the spleen from other types of splenomegaly. The upper left quadrant tumor with the accompanying weakness, pain, and resulting pressure symptoms might be found in any splenic disease, and although several diagnostic procedures have been suggested by different writers, viz.: tuberculin reaction, splenic puncture,

[1] WINTERNITZ, M. C. Tuberculosis of the spleen. *Arch. Int. Med.*, 9: 1912.

[2] PRICE, A. E., and JARDINE, R. L. Primary tuberculosis of the spleen, clinical resemblance to Banti's disease, with report of 3 cases. *Ann. Int. Med.*, 4: 1574–1783, 1931.

etc., it is only by microscopic study of the splenic tissue after laparotomy, that the diagnosis can be established with certainty.

Bunch[3] declares:

> The diagnosis of primary tuberculosis of the spleen is not often made before operation. Magnac reports that the pre-operative diagnosis was made only once in 19 case reports reviewed by him. When splenomegaly does not conform to any of the better known types of splenic anemia, when the blood picture is inconclusive, when the symptoms are indefinite, when there is apparently essential splenomegaly, tuberculosis should be suspected and an attempt made to get a history of exposure to tuberculosis or of some previous disease that might have been tuberculosis. If there are large calcifying masses in the spleen they may be recognized by *x*-ray and the diagnosis be assured.

These nodules were found in the case reported by Bunch; apparently, however, he did not make a diagnosis of tuberculosis before operation.

Practically all authorities agree that the blood picture is very inconstant. Both the red and white cells may be normal, increased, or decreased. The spleen may or may not be enlarged. Several patients have been operated upon with a diagnosis of Banti's disease, on account of enlarged spleen and gastrointestinal hemorrhage. A few cases simulated purpura hemorrhagica, with mucous membrane and subcutaneous hemorrhage. In most of the cases there has been evidence of sub-standard strength and health. The disease may run a very chronic course, but here, as elsewhere in tuberculous disease, acute flare-ups accompanied by fever and other evidence of acute toxemia are liable to develop.

A few other authors likewise mention opacities which are seen at times in a roentgenogram of the spleen. But, as far as can be determined, no one has attributed diagnostic clinical significance to these *x*-ray shadows in the spleen, or on account of them advised operation.

[3] BUNCH, G. Primary tuberculosis of spleen, with report of case simulating Banti's disease. *South. M. J.*, 24: 764-768, 1931.

In the past two years we have had occasion to operate on 3 patients with primary tuberculosis of the spleen in which we made a correct preoperative diagnosis:

FIG. 1. Roentgenogram of splenic area, Case 1, showing calcareous nodules.

CASE 1. Mrs. R., aged thirty-six years, was first seen in 1923, when she complained of an aching in the shoulders, back, and arms, and of a general feeling of malaise. Tuberculosis was suspected, but could not be found on physical examination, and an *x*-ray picture of her chest was negative. She returned to the office at various dates during the next seven years, at times feeling better, at other times not so well, but always below normal physically. Throughout these years she was able to carry on her house work; and in March, 1930, she gave birth to a baby. In June, 1930, she reported to the office with a severe case of mumps and high fever. She was then found to have an enlarged spleen. An *x*-ray of her chest was again negative for tuberculosis. One sister had died with tuberculosis. She was admitted to the Baptist Hospital September 9, 1930, with a history of having had fever constantly for two months, as high as 102°F. in the afternoons. Her general condition appeared quite good, considering that she had had fever for two months. On admission her hemoglobin was 80 per cent; leucocytes,

4400, with 47 per cent small lymphocytes; red cells, 4,400,000; blood platelets, 175,000. Urine negative. Blood negative for typhoid fever, malaria and undulant fever. On taking an *x*-ray of the gall bladder four or five

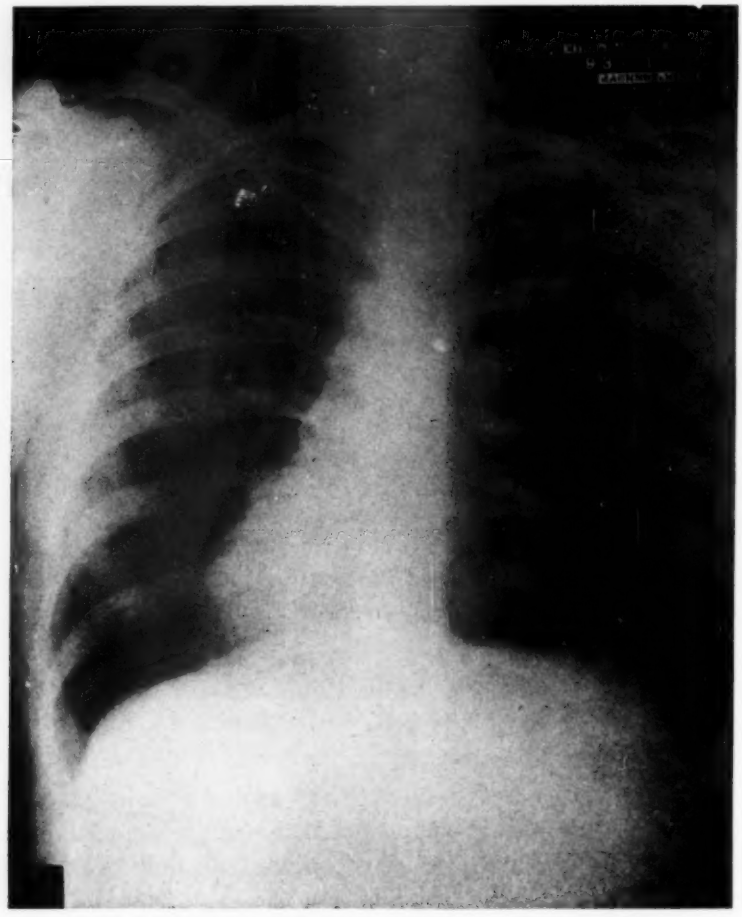

FIG. 2. Chest *x*-ray, Case 1; no evidence of tuberculosis.

large calcareous nodules (Fig. 1) were found in the left hypochondriac region, or lower chest. An *x*-ray of the chest (Fig. 2) showed no involvement, and it was clearly seen that these calcareous nodules were in the spleen, which was enlarged and extended one finger's breadth below the costal border.

It is well known that tuberculosis of the spleen does not usually cause anemia, and that tuberculosis in general is more prone to cause calcareous changes than any other disease. The *x*-ray apparently showed one large calcareous gland on the right side of the spine. After carefully weighing all

the evidence a diagnosis of tuberculosis of the spleen was made and splenectomy advised. This was performed under spinal anesthesia on September 13, 1930. On exploration of abdomen no pathology was found except in the

FIG. 3. Section of spleen, Case 1, showing two calcareous nodules.

spleen, which was twice normal size and contained five calcareous nodules as large as a marble. The spleen was removed (Fig. 3) and the abdomen closed without drainage. Dr. Thompson of the National Pathological Laboratory reported these calcareous nodules, from the spleen, to be due to an old bovine tuberculous infection. After the operation she was kept in bed on a porch for several months on an antituberculosis regime. She improved constantly and rapidly regained her health and strength. She now weighs 40 pounds more than she did two years ago and is apparently well. In this case involvement of the spleen was no doubt secondary to involvement of a lymphatic mesenteric gland. No evidence of tuberculosis could be found anywhere else in her body.

CASE II. Mr. H. M. G., aged forty-one years, carpenter, entered the hospital December 28, 1931, complaining of pain in the left upper abdomen. Family history was negative. Since 1925 the patient had noticed a lack of

FIG. 4. Patient, Case I, two years after operation.

strength and endurance. One year before admission he began to have pain in the left side of his back and upper abdomen. At first this was not severe enough to cause him to stop work, but was aggravated by fatigue. On September 10, 1931, he developed acute pain in the left upper abdomen associated with nausea and vomiting. The pain was severe enough to require morphine for relief. For the next three and one-half months he ran an irregular, septic fever, associated with chills, the fever often going as high as 104°F. He was free of fever for one week before admission to the hospital. Dr. Stephenson, his home physician, had exhausted every effort to determine the cause of the fever. His appendix had been removed in September by Dr. Stephenson. About December 1, 1931, a positive test for undulant fever was obtained from the Board of Health. This test was

later negative at the Baptist Hospital. Dr. Stephenson had taken an *x*-ray picture (Fig. 5) which demonstrated many calcareous nodules in the spleen. On admission to the hospital the patient's pulse was 140,

FIG. 5. *X*-ray showing calcareous nodules in spleen, Case 11.

though he was a fairly healthy looking man. His throat and teeth were negative; there were no enlarged glands; and physical examination of heart and lungs revealed no evidence of disease. The *x*-ray of his lungs (Fig. 6) was also negative, but the *x*-ray of the spleen showed many calcareous nodules in the spleen. His hemoglobin was 90 per cent; red cells, 4,480,000; leucocytes, 5400 with 57 per cent neutrophiles. It was remarkable that a patient could have been sick for three and one-half months with so little anemia. The spleen extended two fingers' breadth below the costal margin and was tender. A diagnosis of tuberculosis of the spleen was made and splenectomy done under ether anesthesia December 28, 1931. A left upper rectus incision was made, and when the abdomen was opened the spleen was found densely adherent to the abdominal wall and all surrounding structures. There was an abscess the size of a lime in the great omentum, attached to the anterior edge of the spleen. The entire surface of the spleen had to be dissected from the surrounding structures on account of the organized adhesions. The spleen (Fig. 7) was enlarged to four times normal size and contained many calcified nodules and multiple abscesses. Tubercle

bacilli were found in the pus from one of these abscesses. The upper pole of the spleen was densely adherent to the diaphragm and was filled with calcified tuberculous masses. Bleeding from the diaphragm was controlled

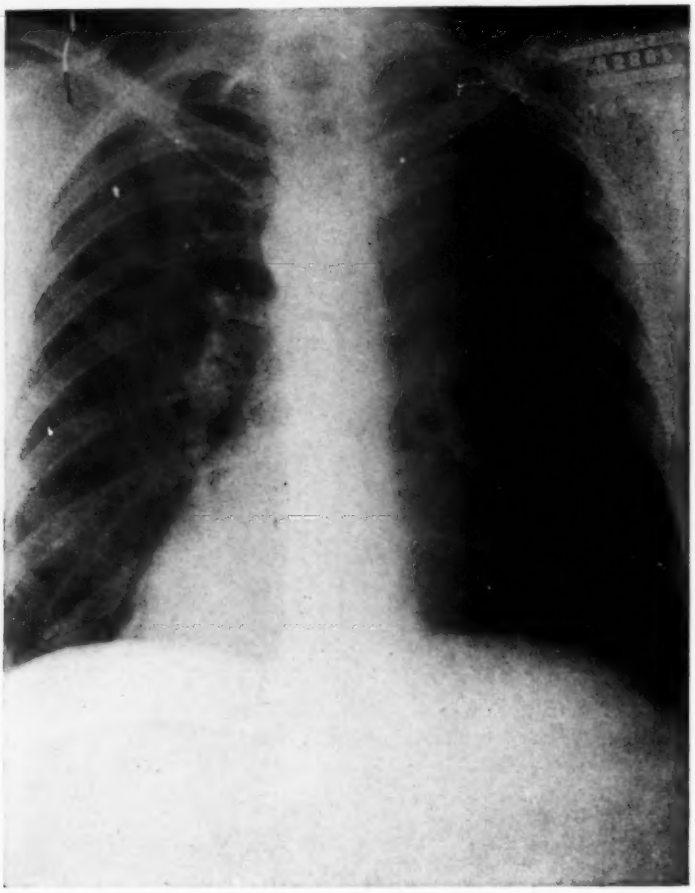

FIG. 6. *X*-ray of chest. No evidence of pathology.

with a large warm pack. A rubber tissue drain was left to the subphrenic space. The right side of the abdomen was not explored on account of the adhesions around the spleen and the presence of the abscesses. A blood transfusion was given during the operation. He had a rather stormy convalescence, but was discharged from the hospital January 13, 1932, in an ambulance. He remained in bed on treatment for tuberculosis for several months. The patient was seen again October 30, 1932, at which time he was in excellent health, having gained 20 pounds in weight (Fig. 8). He was advised not to work for several months, though he seemed well on the road to recovery.

Bacteriological examination of the pus from the abscess in the spleen revealed acid-fast bacilli. The tissue was submitted to Dr. Thompson of St. Louis, who reported: "Specimen received—a portion of spleen. This

FIG. 7. Section of spleen, Case 11. Multiple calcareous nodules. Tubercle bacilli found in abscess around nodules.

shows several grayish white circumscribed nodules measuring from 1.5 to 3 cm. in diameter. One of these nodules is filled with cheesy (caseous) material, others are firm and two are calcareous (solid with lime salt deposit). Sections show practically an end process: calcification and caseation with lymphocytic and endothelial cell proliferation. Only a rare tubercular giant cell found. There is no active inflammatory exudation."

This tissue was sent also to the Cancer Research Laboratory at Johns Hopkins University. Dr. Geschickter's report from there was as follows: "The section shows splenic pulp with germinal centers. Marked increase in fibrous stroma, areas of softness and hyalinization. Most of the areas show granulation tissue of the chronic type without coagulation necrosis of giant cells. In other areas there are large coagulated hyalinized areas surrounded by fibrous tissue. It is difficult to say the type of process which has taken place. This is a remarkable case particularly because of your

findings on smear. We have had practically no cases of primary tuberculosis of the spleen. We are particularly anxious to have this section for the general meeting of pathologists to see whether or not they can identify

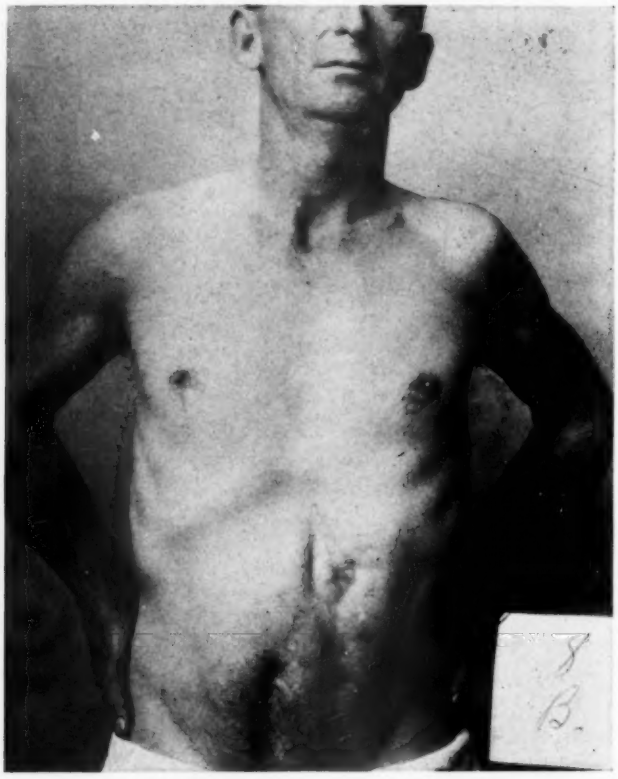

FIG. 8. Patient, Case II, six months after operation.

it as tuberculosis. In the first section cut there is no evidence of infection, although the circular hyalinized areas are highly suggestive. Thank you for sending this case. May we have further report and subsequent clinical course of this patient? We will let you have a further report, as we are cutting this for demonstration purposes and will get many opinions."

At a later date he wrote: "Thank you for your further report on the case of tuberculosis of the spleen. A re-study of the paraffin sections suggest healed tubercles. I have been able to find epithelioid cells and occasional giant cells which I did not see in the original frozen section. I am inclined to agree with your diagnosis and appreciate the material you sent."

When we discussed with Dr. MacCarty, of the Mayo Clinic, the doubtful histological reports which had been received on this tissue, he made the following statement: "I have seen renal lesions (grossly

typical of tuberculosis) with acid-fast bacilli in ureteral catheterized urine and no definite histological picture of tuberculosis." So it seems that the histological pathological picture in old, chronic tuberculous lesions often

FIG. 9. *X*-ray of splenic area, Case III.

does retain its original characteristics.

CASE III. A. H., a colored male, forty-two years of age, was admitted to the hospital July 25, 1932, complaining of pain in the back. He had been coming to the Veterans Bureau for years on account of failing strength and pain in the back. The calcareous areas in the spleen were found incidentally in an *x*-ray picture (Fig. 9) of the spine, which had been ordered by the Veterans Bureau. Since 1920 he had suffered pain in the left lower portion of his back, which was made worse by heavy work. There was no history of chills or fever, though his general strength had been rather poor and he tired easily. He had been trying to farm, but was able to do only about half his normal amount of work. Nothing remarkable was found on physical examination except that he appeared to be below normal in strength and endurance. There was no enlargement of the spleen. An *x*-ray

of his lungs revealed considerable fibrosis (Fig. 10), but no evidence of active tuberculosis. On account of the general symptoms and the *x*-ray shadows in the spleen a diagnosis of tuberculosis of the spleen was made,

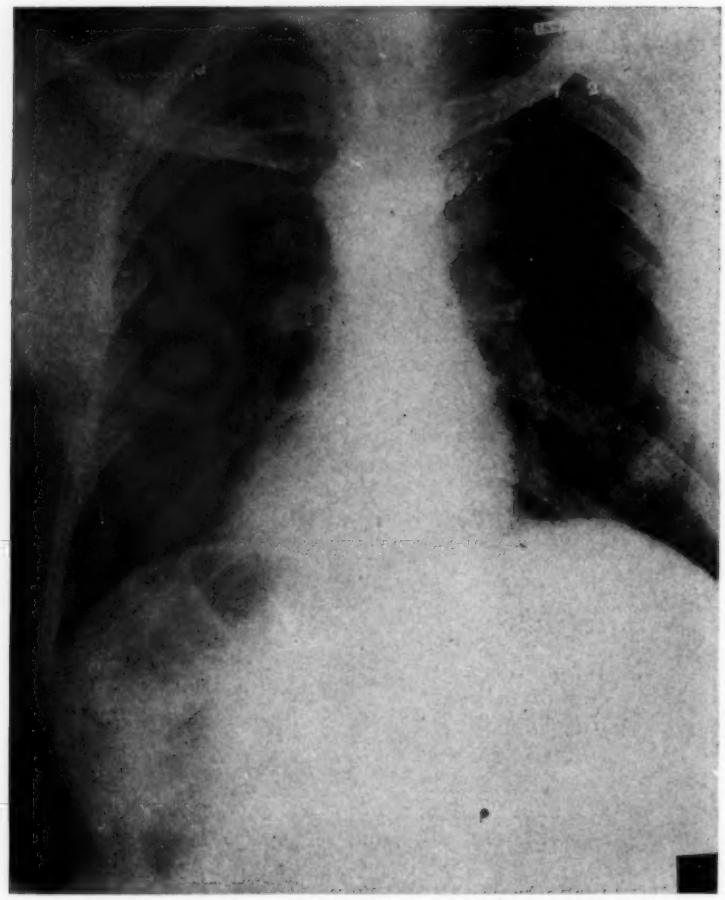

FIG. 10. *X*-ray of chest, Case III.

and on July 28, 1932, the spleen was removed under spinal and ethylene anesthesia. The spleen was markedly adhered to the abdominal wall and to the diaphragm, and contained calcareous nodules. The spleen was only slightly enlarged. There were also fibrous adhesions between the liver and diaphragm. The patient made a satisfactory convalescence and at no time appeared to be seriously sick, though he ran a low grade fever (from 99.5 to 100°F.) each day until the 15th of August. The wound healed without surgical complications. An emulsion of the spleen immediately surrounding the calcareous nodules was made and injected into two guinea pigs. These guinea pigs died a month later. Autopsy of the guinea pigs showed caseous

glands with acid-fast bacilli. The necessity of continued rest and an anti-tuberculosis regime was urged upon the patient. November 1, 1932, he wrote: "Just a few lines to let you hear from me. I am getting along nicely.

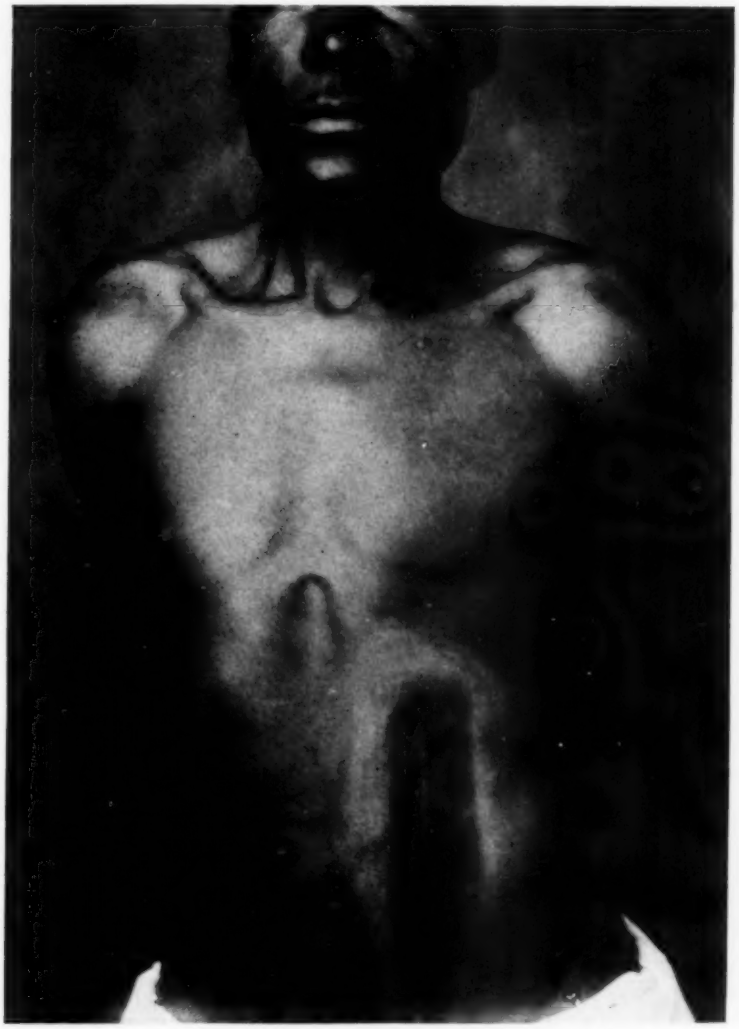

FIG. 11. Patient, Case III, four months after operation.

I have been back from the Veterans Hospital at Tuskegee, Alabama, two weeks today and I weigh 165 pounds, and am still gaining. I believe I am going to 200 before Christmas. I feel better than I have felt for five years."

In each of these cases it was noted, as it has been by other observers, that the splenic artery was abnormally small.

These pictures have been submitted to various distinguished roentgenologists and tuberculosis specialists to obtain their views of the true diagnostic significance of these *x*-ray

FIG. 12. Roentgenogram, splenic area, Dr. Bunch's case. Calcareous nodules shown.

shadows. Dr. George W. Holmes, of Boston, writes:

I received your letter, also the views of *x*-rays and pathological specimens. I am very much interested in this finding, and have no doubt that your diagnosis is correct. I have never, personally, seen such a case, but Dr. Ruggles showed me films several years ago, and you will find a reference to it in our book, Roentgen Interpretation, on page 22. From the point of view of the roentgenologist the only thing which one would be likely to confuse with such an appearance would be stones in the tail of the pancreas, which are very rare.

Dr. John D. Camp, of the Mayo Clinic, writes:

> Personally, I do not recall having seen a roentgenogram showing large irregular calcification in the spleen such as you have noted. We have usually interpreted these small, miliary shadows of calcification as a healed tuberculous infection and our pathologist, Doctor Robertson, agrees with me in this opinion. Personally, I know of no other condition that will produce gross calcification in the spleen other than tuberculosis.

Dr. Camp has observed many cases of small miliary calcifications in the spleen.

Both Drs. Lawrason Brown and Gerald B. Webb thought these roentgenograms indicated healed tuberculosis of the spleen. Of course, in these particular cases the lesions were not healed, for two of the patients were acutely ill with high fever for two or three months before operation and recovered only after the spleen was removed. The third patient had a chronic tuberculous toxemia. He is also improving rapidly after splenectomy.

In 35 out of 51 of the cases collected by Dr. Winternitz a note is made that the spleen contained caseous tubercles or nodules. And indeed in the whole body of the literature the pictures of the tuberculous spleens which have been removed practically all show these caseous nodules. This is the most common pathological finding, and apparently an *x*-ray will demonstrate this condition.

In the light of all the foregoing we are inclined to believe it fairly certain that by means of an *x*-ray of the splenic area a correct diagnosis may be made in the vast majority of cases of chronic primary tuberculosis of the spleen.

HEMOLYTIC JAUNDICE

REPORT OF FIVE SPLENECTOMIES IN ONE FAMILY

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THE cases of hemolytic jaundice in which operation was performed by the writer number 6, 2 adults and 4 children. Five of the patients were in one family, consisting of the mother, two daughters, a son and a nephew.

CASE I. G. DeW., painter, aged thirty, admitted to Mercy Hospital, Baltimore, November 9, 1924, with the complaint of severe pain in the splenic region and partial paralysis of the right forearm; discharged May 31, 1925.

Family History. He had typhoid at the age of nine; diphtheria at twenty-four; he had attack of pain in the splenic region five years ago, and lost six weeks from work. The spleen was enlarged and the family physician diagnosed the condition as splenitis. The patient was refused admission in the Army in 1917 because of physical unfitness. He has been jaundiced since childhood and was nicknamed "yellow." Six years ago he had rheumatic attacks involving various joints.

Present Illness. Two weeks prior to admission he began to have marked loss of energy, tiring easily, and some swelling of the ankles toward evening. He had several attacks of pain in the splenic region, at first intermittent, later constant.

Physical Examination. Examination showed him to be a reasonably well-developed man, markedly jaundiced, the spleen enlarged to three fingerbreadths below the costal margin. Partial paralysis of the right forearm muscles, thought to be due to lead poisoning, was noted. He showed marked evidence of gout, the joints being affected to a degree plainly shown by *x*-ray. Very marked tophi were present in the ears.

Laboratory Examination. The stools were dark but contained no blood. Before operation, December 9, 1924: hemoglobin 40 per cent; R.B.C. 1,850,000, reticulated R.B.C. 11 per cent; fragility: hemolysis began at 0.75 per cent, complete at 0.35 per cent; urobilin negative; Vanden Bergh reaction, November 14, 1924, light greenish hue; bleeding time five and one-half minutes; coagulation time seven minutes.

X-ray November 14, 1924: of the forearm and hand showed bone absorption of the distal ends of the first phalanx and base of the second

phalanx of the little finger of the left side with approximation of the joint surfaces; and some striation and thinning of the cortex of the distal ends of the radius and ulna and metacarpal bones.

X-ray February 21, 1925: Both hands showed bone destruction in the same finger locations, the bone changes probably mostly due to the gout.

After operation May 12, 1925: Hgb. 75 per cent; R.B.C. 4,480,000; reticulated R.B.C. 0.4 per cent; fragility: began at 0.60 per cent, complete at 0.40 per cent; urobilin negative.

Operation. Splenectomy was done February 25, 1925, without special difficulty. Postoperatively he developed pneumonia, a slight but persistent wound infection and eventually a lung abscess. However, he made a recovery and was discharged May 31, 1925.

His jaundice was promptly relieved by splenectomy and his blood picture made the striking improvement already noted. He returned to the Hospital December 30, 1925 and was found to be quite ill with cardiovascular renal disease and gout. He died January 9 of the following year of a cerebral hemorrhage, uremia and hypertension.

CASE II. E. S., aged eleven years, was admitted November 16, 1927, complaining of impaired vision (complete loss of vision of the right eye, partial loss of vision of the left eye). Discharged December 14, 1927. Jaundice was present at birth, and had appeared periodically ever since.

Family History. The mother, who was subject to attacks of jaundice, died of influenza at the age of twenty-three. (For balance of family history see next case.)

Past History. He had chicken pox at the age of six; whooping cough at the age of seven; and nineteen months ago had jaundice with anemia, diagnosed malarial fever. It was during this attack that he became blind in both eyes. Vision in the left eye returned to some extent but did not in the right. He has had pneumonia, typhoid, scarlet and rheumatic fevers, chorea and an occasional sore throat.

Present Illness. Jaundice, present at birth, cleared up at three weeks but from the age of three months to seven years he had attacks of jaundice every two or three weeks, confining him to bed for two or three days. He was normal between attacks. After the age of seven, the attacks were more frequent and more severe. During the attacks he had fever, was nauseated and had pain in the right side under the costal margin. His appetite was enormous, he had no indigestion, the stools were brown, and no loss of weight was noted.

Physical Examination. The patient was jaundiced, the tonsils red and enlarged. The liver edge was two fingerbreadths below the costal margin. The spleen was easily palpated, two fingerbreadths below the costal margin. Examination of his eyes by Dr. Harry Friedenwald showed

a "post-neuritic atrophy with only light perception on the right side, less affection of the left."

Laboratory Examination. Before operation, October 20, 1927: Hgb. 85 per cent; R.B.C. 4,700,000; retic. R.B.C. 6.7 per cent; fragility: began at 0.75 per cent, complete at 0.45 per cent; urobilin negative; Vanden Bergh reaction: direct negative, indirect positive; 9 mg. bilirubin per 100 c.c.; coag. time three and one-half minutes.

X-ray December 8, 1927: The sella turcica was normal.

After operation, December 9, 1927: Hgb. 60 per cent; R.B.C. 3,890,000; Retic. R.B.C. 1 per cent; fragility: began at 0.50 per cent, complete at 0.35 per cent; urobilin negative; Vanden Bergh reaction: prompt direct negative, indirect positive; 2.6 mg. bilirubin.

September 4, 1929: Hgb. 92 per cent; R.B.C. 4,200,000.

Operation. Splenectomy was performed November 21, 1927, there being no special features to the operation except that an accessory spleen about as large as the end of the finger was found attached to the peritoneum in the splenic region. This was not removed. The liver was engorged. No gallstones were present. The postoperative course was smooth, the temperature not going above 100.6°F., the pulse never above 110, no complications.

CASE III. B. S., aged twenty-eight years, was admitted January 8, 1930, complaining of jaundice and pain in the right upper quadrant. Discharged March 5, 1930. The pain was intermittent and dull, radiating to the right shoulder blade. This attack began three weeks ago but she has had attacks for ten years, which gradually became worse. She has nausea after eating rich foods.

Family History. The paternal grandmother had attacks of jaundice, and died at seventy-five of liver trouble. The father's sister, now seventy-seven, has periodic attacks of jaundice. She had a daughter (a cousin of the patient) who began at thirteen to have attacks of jaundice and died at thirty-five of pneumonia. The latter had two children, neither showing trouble.

A paternal aunt died early, with no history of jaundice. Two paternal uncles had periodic attacks of jaundice, not so severe as those of her father, who died at fifty-three of jaundice and Bright's disease and was known to have a large spleen. The two uncles have one child each, asymptomatic. The patient has two sisters living and well. One has a son ten years old, well. One sister, who was subject to attacks of jaundice, died of influenza at the age of twenty-three. She had a son, being reared by the patient. He is herewith reported as Case II.

The patient has four brothers, aged twenty-four, nineteen, seventeen and twelve. The oldest has periodic attacks of jaundice, is married, has two girls and a boy. They have no jaundice. The patient has four children

of her own, three of whom are herewith reported as cases of congenital hemolytic jaundice; the fourth is asymptomatic.

The eldest brother was recently operated upon by me for a minor complaint but examination August 11, 1932 showed R.B.C. 4,060,000; W.B.C. 15,000; polys. 98 per cent; eos. 2 per cent; anisocytosis of slight degree; bleeding time three min.; coag. time nine min.; fragility: hemolysis began at 0.65 per cent, complete at 0.3 per cent.

Past History. The patient has had measles, mumps, scarlet fever, whooping cough, influenza, pneumonia and typhoid fever. At the age of eighteen she began to have attacks of biliousness, followed by jaundice which lasted three or four days. These later became more frequent and were accompanied by some pain and lasted longer.

Present Illness. This attack began November 25, 1929, gradually getting worse. By December 15, she was in great pain and so jaundiced that she was told she appeared green. She had considerable pain in the gall-bladder region. She suffered a considerable indigestion, though her appetite was good. She also suffered shortness of breath upon exertion and her ankles swelled toward evening.

Physical Examination. The patient was a well-nourished individual, deeply jaundiced; the heart and lung findings were negative; the abdomen relaxed. The liver was not enlarged. The spleen extended 4 to 6 cm. below the costal margin.

Laboratory Examination. Before operation: January 9, 1930: Hgb. 62 per cent, R.B.C. 2,750,000; retic. R.B.C. 14.2 per cent; fragility: began at 0.60 per cent, complete at 0.30 per cent; urobilin positive; Vanden Bergh reaction: prompt direct positive; 18 mg. bilirubin; bleeding time, three min.; coag. time four min. forty sec.

X-ray January 10, 1930: Right arm and leg were negative. The tables of the skull were somewhat thicker than normal, especially the frontal bone; there were alternate areas of increased and decreased density in the inner table of the frontal bone at the vertex.

After operation March 2, 1930: Hgb. 79 per cent; R.B.C. 3,640,000; fragility: hemolysis began at 0.55 per cent, complete at 0.30 per cent; Vanden Bergh reaction: delayed direct positive; 0.9 mg. bilirubin.

X-ray February 21, 1931: Same as before operation.

X-ray March 2, 1931: Same as previously reported.

Operation. Splenectomy was done February 10, 1930; left Bevan incision. The spleen was found to have accessory vessels leading to what appeared like a second hilus along the anterior border. These vessels were ligated first and then with a Cameron light adhesions to the diaphragm and the lienorenal ligament were found to be non-vascular, so the spleen was delivered and removed without difficulty, though it required consider-

able dissection to free the tail of the pancreas. The gall bladder was palpated and contained at least one stone. This was near the cystic duct and was pushed out of this region but was not removed as it was desired to make the operation brief. The abdomen was closed without drainage. The patient suffered considerable postoperative pain and vomited for several days, but after the third day, convalescence was smooth. The jaundice began to disappear promptly and did so rapidly. The blood picture promptly showed improvement. There were no complications.

CASE IV. E. S., aged six years, was admitted May 24, 1930; complaining of periodic gastrointestinal upsets with jaundice and also nasal obstruction. Discharged August 17, 1930. Her nose condition was treated and while she was in the hospital, she was found to be suffering with a mild type of hemolytic jaundice.

Family History. This patient is a daughter of B. S., reported as Case III.

Past History. Jaundice was present for the first few weeks after birth. She has had scarlet fever and chicken pox, and considerable trouble with the nose and throat.

Present Illness. For several years the patient has had periodic attacks of some form of gastrointestinal attacks associated with vomiting; she also has the nasal obstruction referred to with frequent colds and sore throats.

Physical Examination. She shows slight jaundice and otherwise findings are negative except for the nose and throat condition and a moderately enlarged spleen.

Laboratory Findings. May 28, 1930: Hgb. 70 per cent; R.B.C. 3,250,000; retic. R.B.C. 5.1 per cent; hemolysis began at 0.60 per cent, complete at 0.30 per cent; urobilin positive; Vanden Bergh reaction: prompt direct negative, indirect slightly positive; 0.9 mg. bilirubin; bleeding time three and one-half min.; coag. time one and one-half min. After operation, August 11, 1930: Hgb. 87 per cent; R.B.C. 5,200,000; retic. R.B.C. 0.5 per cent.

X-ray July 8, 1930, of the skull was negative.

July 21, 1931: Slight increase of diploic tissue of skull with thinning of outer table in parietal bone giving appearance of vertical striation. Forearms negative.

The patient's symptoms and signs were considered by the medical staff to be sufficiently severe to justify splenectomy and, after a transfusion, this was done on June 23, 1930. The operation was unusually simple and the postoperative course was smooth except for mild but persistent infections about the silkworm-gut sutures and also about the face and scalp.

CASE V. M. S., aged nine years, was admitted to Mercy Hospital July 4, 1930, with high fever, pain in the abdomen and vomiting.

Family History. There is a history of jaundice in infancy. She has had scarlet fever and whooping cough. One year before admission she had "toxic poisoning."

Present Illness. The patient has been in fairly good health until a few days ago when she began to have fever and abdominal pain. Upon admission she was found to be acutely ill. Her temperature was 105.4°F., pulse 130, respirations 30.

Physical Examination. Marked jaundice was present and the spleen extended almost to the umbilicus. She was found to be suffering with a pyelitis as a complication or possibly as the exciting cause of a crisis of hemolytic jaundice.

Blood examination, July 11, 1930, showed Hgb. 41 per cent; R.B.C. 2,470,000; retic. R.B.C. 16 per cent; hemolysis began at 0.60 per cent, complete at 0.30 per cent; urobilin positive; Vanden Bergh reaction: prompt direct negative, indirect positive; 2.5 mg. bilirubin; bleeding time one and one-half min.; coag. time four min. After operation August 2, 1930: Hgb. 83 per cent; R.B.C. 5,050,000; retic. R.B.C. 1 per cent.

X-rays July 8, 1930 showed no changes in the long bones or skull but on February 21, 1931 there was shown a slight increase in diploic tissue with thinning of the outer table in the parietal bone; some striation; forearms negative.

Operation. The patient was prepared for operation by a transfusion and splenectomy was done July 28, 1930. The operation was quite difficult, perhaps the most difficult of the series, due to the close approximation of the stomach and pancreas to the spleen. The several branches of the vasa brevia were ligated so closely to the stomach as to make it appear unsafe, so they were covered over by suturing the stomach wall with fine silk, a simple procedure which seems to add some safety.

The postoperative course was uneventful except for a slight amount of fever which could not be explained and which was present at the time of discharge, August 17, 1930.

CASE VI. H. S., aged five and one-half years, was admitted to Mercy Hospital February 24, 1931, during a crisis of congenital hemolytic jaundice.

Family History. See history of B. S.

Past History. This was unimportant. He had pneumonia at eighteen months of age and since then has had an internal squint. He escaped the usual childhood diseases.

Present Illness. He was admitted during a crisis of hemolytic jaundice. The skin was jaundiced, the liver enlarged, the spleen border almost at the midline of the abdomen.

Laboratory Findings, February 23, 1931. Hgb. 62 per cent; R.B.C 2,650,000; retic. R.B.C. 11.5 per cent; hemolysis began at 0.45 per cent complete

at 0.30 per cent; urobilin positive; Vanden Bergh reaction: prompt direct negative, indirect positive; 3.1 mg. bilirubin.

After operation May 16, 1931, blood examination showed Hgb. 70 per cent; R.B.C. 4,140,000; urobilin, slight trace; Vanden Bergh reaction prompt direct negative, indirect positive; 2.5 mg. bilirubin.

X-ray March 2, 1931. The tables of the frontal bone were somewhat thinner than normal. No changes were noted in forearms or hands.

Operation. A transfusion was given April 24 and April 27 a splenectomy was done, the operation being easy. A small body about the size of the exposed lead in a pencil attached to the omentum proved to be an accessory spleen.

The postoperative course was smooth, the only complication being infections about the fingers, unimportant but interesting in view of the skin infections in other cases.

While it is said that spleens were removed by the ancients to increase the wind of runners and from then on an occasional operation was done following bayonet and other wounds, it has been in the past twenty years and more especially in the past fifteen that there have been really great interest and progress in the development of the knowledge of diseases involving this organ.

The marked confusion of the anemias and other conditions associated with disturbances of the spleen that obtained only a few years ago is rapidly being clarified and the diagnostic characteristics are constantly becoming more definite. Nevertheless, there are still many points in the etiology, diagnosis and treatment of hemolytic jaundice that need study. This is not surprising when one remembers that the whole subject of blood formation and destruction and the pathogenesis of bile is in such an evolutionary state. Some authors doubt that there is a true hemolytic jaundice. Others deny that there is an acquired form. Then there are the interesting subjects of ectopic bone marrow, the question of the influence of splenectomy in hemolytic jaundice in the pregnant, the results of liver treatment and other unsettled problems.

According to Moynihan, the first splenectomy for hemolytic jaundice was done by Sir Spencer Wells in 1887. The second

reported operation was done by Bland-Sutton in 1895. From the accounts of these cases, the diagnosis seems to have been fitted later to the original description and subsequent course. Probably the first case diagnosed as hemolytic jaundice for which splenectomy was recommended was the one done by Banti in 1903 and reported in 1912.

Outside of large clinics, it does not fall to the lot of many surgeons to see a great number of these patients. Hence it seems that any large total must be, for the most part, made up of small series, this being the justification for this report and the reason for some of the details mentioned.

The cardinal symptoms and signs of chronic hemolytic jaundice, viz. acholuric jaundice, enlarged spleen, anemia, crises with pain and fever, increased fragility of the red cells, increased reticular cells, urobilin but no bilirubin in the urine, normal colored stools, increased icteric index, negative Vanden Bergh reaction and the absence of itching, are now well established and though the diagnosis may at times be difficult, it can usually be made with reasonable certainty. It should be remembered that 60 per cent of the long-standing cases of hemolytic icterus have associated gallstones which may produce an obstructive jaundice resulting in the group of symptoms usually associated with this condition, including a direct Vanden Bergh reaction.

Some authors speak of the osseous changes in hemolytic jaundice as being quite definite. In this series, these were not particularly striking, though some changes were found; more pronounced in the adults than in the children (thus ruling out Von Jaksch's disease). In only one case, M. S., was the mongoloid facial appearance noticeable and this was not striking.

Some cases of hemolytic jaundice are said to be so mild as to need no treatment, or, at least, not to justify operation and that a considerable number of the patients live long lives and die of other diseases. On the other hand, many patients suffer crises of severe and increasing degrees demanding relief, and too, in the cases which may not emphatically demand

operation, some seem to show a lowered resistance or constitutional debility quite strikingly seen in some of the histories reported; this being particularly true in children. The small experience herewith reported has led to the feeling that in the congenital cases the patients are frequently more seriously ill than one might be led to believe from the literature.

Chauffard's epigrammatic statement that these patients "are more jaundiced than sick" has not held true in this series. It is important to differentiate between latent cases and those manifesting symptoms. Four of my 6 patients were quite ill and, while 2 were made more so by complications, nephritis and gout in one instance and pyelitis in the other, the crises themselves with the resulting pain, jaundice and anemia, were probably sufficient in these, as they were in the other two, to give considerable concern. A fifth and the mildest case, Case IV in this series, showed a red cell count of 3,250,000, hemoglobin of 69 per cent, not a grave anemia but, in the light of what had occurred in her cousin and mother, it was not felt by the medical department that it would be proper to allow her to go without treatment. The benefits were plainly seen in the almost immediate disappearance of the slight jaundice, and in three months the blood count was 5,200,000 and the hemoglobin 87 per cent.

Hemolytic jaundice has been classified as congenital and acquired, the acquired cases being described as the more severe.

It is even noticed in the literature that mild cases are called congenital and severe cases classed as acquired, because they are severe, regardless of their histories. (If this classification is continued, it would, of course, be more reasonable to classify them by history rather than by severity, but, as stated, lately doubt has been cast upon the acquired cases and it may be that this class will be omitted and all cases recognized as congenital.) No case that could be considered acquired has come to my notice.

It seems to be well established that the treatment of this condition is surgical and consists of removal of the spleen. Apparently splenectomy can be done at quite early ages. Bell's patient, aged fifteen months, is perhaps the youngest reported in America, but Taylor, in England, has reported splenectomy in children nine, eleven and thirteen months of age. X-ray and radium have been used in this condition but not with any degree of success. Within a few days after splenectomy, the jaundice begins to fade rapidly and goes on to complete disappearance. Immediately after operation there is often found a slight exaggeration of the anemia but this is soon corrected and the red cells rather rapidly increase. The fragility of the red cells, in practically all cases, remains greater than normal. Some instances of recurrence of jaundice and crises have been noted, but these are rare and none has come under my observation. The danger of attributing this to hemolytic jaundice when it may be due to gallstones, or some biliary tract disease, must be borne in mind.

It is very necessary that operation be done between attacks, that is, not in a crisis, as in the earlier operations this was undoubtedly responsible for some deaths. It has been estimated that in a crisis as much as one-half or more of the blood cells may be destroyed. In most clinics, it is customary to give a transfusion before operation and to be prepared to give one or more after operation, if necessary. However, other observers warn that there is danger in preoperative transfusions of increasing the jaundice and causing a blocking of the kidneys, with anuria. If the spleen is very large, it may be decreased in size by the administration of adrenalin just before operation. Preoperative *x*-ray and radium have been used for this purpose, but adrenalin is considered more effective. It often has been stated that the spleens in these cases are rather easily removed and it seems true that they are not commonly so adherent as in the splenic anemias and some other conditions. However, this ease of removal cannot be relied upon. In two sisters, aged six and nine, one splenectomy was very easy

and the other was quite difficult, not on account of adhesions so much as short vessels. In the other 4 cases, there were adhesions but they were not particularly vascular. I have recently heard of a capable operator who had to abandon the removal of the spleen in a case of hemolytic icterus on account of adhesions and the danger of hemorrhage and I know of 2 other patients operated upon by colleagues in whom the spleens were quite adherent. I have found the cold light very useful in estimating the thickness and vascularity of adhesions.

In a case where adhesions are so extensive and difficult as to make splenectomy too dangerous or impossible, the question of ligation of the splenic artery is to be considered. Some work on this subject has been done in this country experimentally but very little clinically. Considerable attention has been given abroad to both these phases. In the 1880's this subject was discussed and the operation was done several times with fatal results. It was abandoned until 1904 when an operation was successfully done by Lanz.

In experimental work, the conclusions seem quite uncertain. Some (Litten and Balacescu and Jones) report no necrosis of the spleen following ligation while Wyman considers it sure to follow. There seems, too, quite a difference of opinion as to the best location for the ligature. In spite of the different opinions, there have been reported quite a few successful ligations as a substitute for splenectomy. Most of the reported cases have been for thrombopenic purpura. It is said that the first ligation for hemolytic jaundice was done in 1928 by Alessandri.

The procedures recommended are: (1) ligation near the celiac axis where no vein interferes; (2) a detachment of the colonic insertion of the greater omentum and ligation in the middle third of the vessel; (3) ligation 6–10 cm. from the spleen.

It seems important that the anastomosis between the splenic and gastroepiploic arteries be undisturbed and that the splenic vein be not damaged.

Comparisons between results obtained in ligations in cats and dogs and human beings must take into account that anastomoses are more developed in these animals and the operation is done in the presence of a normal spleen, whereas in man, the condition making the operation necessary is usually a diseased spleen.

Splenectomy in hemolytic jaundice is usually such a satisfactory procedure, in most instances not particularly difficult, that it would seem advisable to reserve ligation for cases with extensive adhesions or some other condition precluding splenectomy or making ligation appear the safer procedure in spite of its uncertain standing at the present time.

Few procedures in surgery give more brilliant results than splenectomy in hemolytic jaundice. The mortality is lower than in any of the other conditions for which splenectomy is done and the results are more certain. In the early series, the mortality, according to Elliott, reporting in 1917, was as high as 16 per cent in 65 cases collected by him. Some recent statistics, for example those from the Mayo Clinic, show a great improvement over these figures. In 118 cases the hospital mortality was 3.4 per cent.

Giffin states "our experience, therefore, indicates more clearly as time goes on the value of splenectomy in hemolytic jaundice. The statistics are thoroughly satisfactory." He mentions no unpleasant or untoward after-effects. Pemberton in a more recent paper is equally enthusiastic. There is a case reported by Dawson of a patient living twenty-seven years after splenectomy, in good health but with increased fragility of the red cells still present.

SUMMARY

Six cases of chronic congenital hemolytic jaundice with splenectomy are reported. Five cases were definitely familial, and in one family. Four patients were quite ill, one was complicated by nephritis and severe gout, one was complicated by pyelitis, one by marked optic atrophy, one of the two

adults had gallstones, two had accessory spleens. After operation one had pneumonia and lung abscess, two had mild postoperative wound infections, one having numerous skin infections about the face, another about the fingers; all patients were promptly relieved of jaundice, all except one had prompt improvement of anemia and his ultimate improvement was satisfactory; in none of those reexamined did the fragility of the red cells become normal. There was no operative or hospital mortality. One patient with nephritis and gout some months later died of cerebral hemorrhage and uremia. Five patients are living and in good health five years, two years and ten months, two and a half years, two years and two months, and one year and nine months after operation. So far we have not observed any steeple skulls and bone changes have been slight. The optic nerve involvement in one case is the only one so far reported.*

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* Since this paper was read, a sixth member of this family has been successfully operated upon:

L. H., the eldest brother of B. S. (Case III) referred to in her family history, recently became incapacitated by marked lassitude and pain in the splenic region. He was suffering with a moderately severe case of hemolytic jaundice, the details of his condition will be reported at a later date. The spleen weighed 640 gm.

This increases the total series to seven.

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END-RESULTS WITH SELECTIVE COLLAPSE THERAPY IN PULMONARY TUBERCULOSIS

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THE purpose of this paper is to set forth the advantages of selective collapse therapy over certain other surgical measures in the treatment of pulmonary tuberculosis. Increasing activity in this field of surgery has brought about radical changes and modifications in the methods of treatment. Many of these changes have proved admittedly non-progressive. But in the latest analysis, our final results show a distinct and gradual improvement. The plan of treatment which I wish to emphasize, and to advocate before this body, is one less radical, less hazardous and more economical than its predecessors. It departs in these respects from the usual course of the surgery of serious disease, which is wont to become more radical and bolder as it advances. But the very nature of the pathology of pulmonary tuberculosis prohibits us from such a course, and encourages the benefits of conservative treatment.

Important advances in thoracic surgery began about two decades ago. The names of Brauer and Dederick, DeCerenville and Spengler are linked with the earliest development of thoracoplasty. And as early as 1885, DeCerenville sounded the same note of conservatism in this operation that we observe today as the most important late development in collapse therapy. DeCerenville reported 4 cases operated on for apical cavities, in which he resected 3–5 cm. of the second and third ribs anteriorly, "or as many as necessary according to the extent of the cavity." The operation entitled complete thoracoplasty was later developed and "perfected" until the so-called Standard Extrapleural Thoracoplasty came to be practiced by all surgeons interested in thoracic work. The

operation consisted in the resection of the first to the eleventh ribs posteriorly. As its popularity increased, astounding results followed that bold surgical procedure. Over 60 per cent of bedridden patients suitable for this operation were sufficiently restored by it to be discharged from tuberculosis sanatoria; which fact was full evidence of its value. This extensive resection of the chest wall became the operation of choice. But we have recently developed a less extensive procedure, which proves equally valuable and notably less hazardous for the majority of our cases.

No presentation of the surgical aspect of pulmonary tuberculosis can open without primary reference to the value of artificial pneumothorax. We recognize it to be the most widely useful measure of all collapse therapy. Its usefulness is greater today than ever before. As long as the possibility remains that artificial pneumothorax will give results, no other collapse therapy should be considered. This procedure has the dual advantage of being easily administered and readily discontinued as indicated; the compression is not necessarily permanent; it is well borne where bilateral collapse is required; and is the least perilous of all collapse therapy.

A review of my series of 100 patients operated on for pulmonary tuberculosis, on all of whom some form of thoracoplasty was done, shows interesting results in the most recent group, each of whom had only a limited selective collapse operation. The first patient on whom I resected only the upper five ribs got such relief from the limited operation that she refused to undergo further surgery. Her sputum became free from tubercle bacilli and the apical cavity remained collapsed. This was in 1924; I feared that this patient would soon be forced by recurring symptoms to return for further collapse therapy. I was aware that certain European authorities were warning against selective collapse; arguing that if the upper ribs were resected and the lower ribs left undisturbed, there would be an extension of the involvement to the lower lobe. But beginning with the above, in my series of such cases

which comprise 33 per cent of my thoracoplasties, I have had no extension of pathology to the lower lobes. Nor has there been any succeeding involvement extending to the contralateral lung, which could be in any way attributed to the operation.

I have followed this small series of cases closely. Our results have been better with these than with our other patients who had the complete or standard thoracoplasty. The selective operation has proved definitely less hazardous. The majority of these operations were completed in one stage and their days in the surgical division were correspondingly reduced.

The 33 cases of this series have had only the upper five to seven ribs resected; the length of the section removed depending on the size of the cavity. In every apical case large sections of the first rib should be resected. For in these selective cases the first rib is literally the key to the situation. It has been well described as "the keystone of the thoracic dome." For a few of our cases, we have removed the first and second ribs *entirely*. The size of the cavity and its location are the governing factors in our choice of procedure.

Our system of approach with cases suitable for selective collapse has been to suit the type of operation to the pathological lesion. A patient who has an apical cavity with a sound lower lobe should have the cavity in the apex obliterated; but the good lower lobe should not be handicapped by the compression resulting from a complete thoracoplasty. We firmly believe that the cavity should be closed, even if it requires multiple stages of operation. In several cases, we have found it necessary to do an anterior resection of the ribs in addition to the posterior operation. The collapse of the cavity is essential to the cure of the patient.

Fragenheim resects the first rib in apical lesions, and Graf, for the same type of disease, removes the first rib, sometimes the second and also decreasing amounts of the third to the fifth, even to the seventh, inclusive. The plan which these authors advocate is similar to the method we began to practice

nine years ago. We discussed it before the Association for Thoracic Surgery in 1928, and its continuing good results we report today.

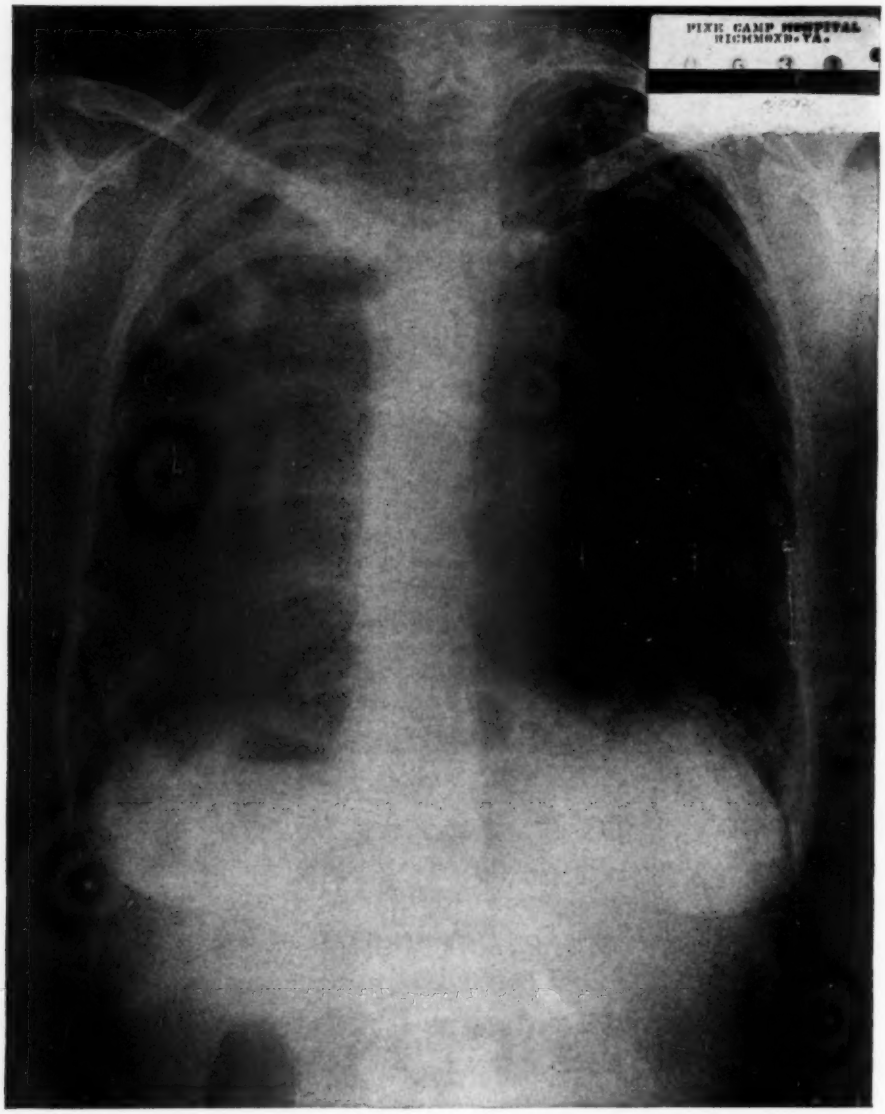

FIG. 1A.

Great benefit is derived by selective groups of patients with pulmonary tuberculosis from the operations on the phrenic nerve. This rather new operative measure has been

greeted enthusiastically by surgeons working in this field. It is a useful procedure if "temporary or permanent paralysis of the diaphragm is desired; for recent thin-walled superficial

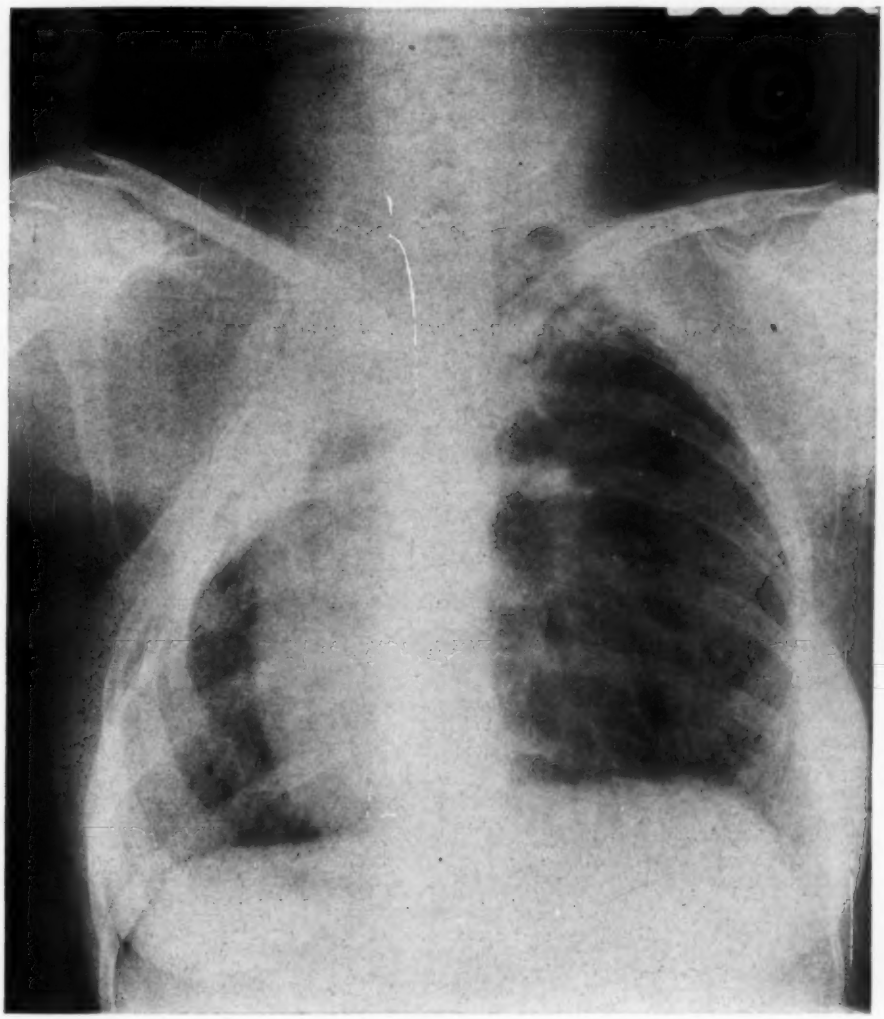

FIG. 1B.

FIG. 1. A and B. Large apical cavity. Phrenicotomy, no results. Thoracoplasty, resection of four upper ribs, cavity closed.

cavities; for moth-eaten, soft-walled cavities; as an aid to pneumothorax when the base of the lung remains uncollapsed and with or without diaphragmatic adhesions. It is seldom indicated in patients with adhesions immobilizing the dia-

phragm, or in patients with acute progressive disease."[1] Where surgery of the phrenic nerve was indicated, alcohol injections, crushing of the nerve and phrenicectomy have given sur-

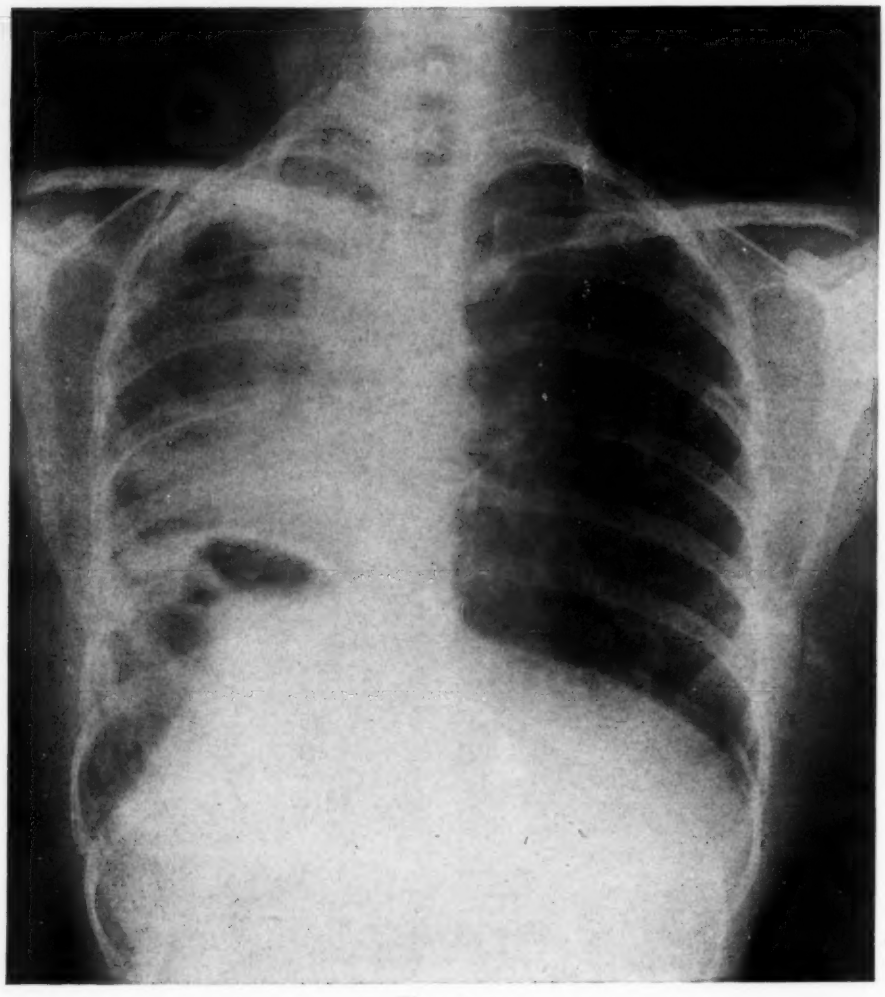

FIG. 2A.

prisingly good results. In a small percentage of our cases, these results were so satisfactory that no further selective collapse operation was indicated.

[1] See JOHNS, F. S., and COLE. End results with selective collapse therapy in the treatment of pulmonary tuberculosis. *J. Thoracic Surg.*, 2: 247–254, April, 1932.

We now advocate and practice the importance of allowing this less extensive and safer operation on the phrenic nerve to prove its utmost usefulness before we proceed with a thora-

FIG. 2B.

FIG. 2. A and B. Bilateral cavitation of both apices. Upper bilateral thoracoplasty.

coplasty. We have abandoned our former plan of doing this operation as merely a preliminary or index to a more radical procedure. It has earned a place of its own among our surgical resources and should be accorded plenty of time after the operation to effect its maximum results.

I have had no personal experience with "Fills" in the treatment of pulmonary tuberculosis. Archibald, Alexander, Harvey, Dumarest, Berard and Felix, Maurer and Rolland all vary in their opinions of their value.

Felix's report is of interest because of his close association with Sauerbruch's work and for the large number of his reported cases. Felix states that "in cases where pneumothorax has succeeded and where thoracoplasty promises success, Fills must be put aside; for pneumothorax and thoracoplasty constitute our sovereign methods in the treatment of pulmonary tuberculosis."

The observation of Maurer and Rolland strengthens Felix's views. They state that the Fill must be considered an "exceptional method."

I would urge a more intensive surgical treatment of patients with pulmonary tuberculosis. In some of the leading tuberculosis institutions more than 75 per cent of the patients receive some form of collapse therapy: pneumothorax, phrenicectomy and thoracoplasty. Such active treatment lowers the immediate mortality and also materially shortens the patient's stay in the hospital. Pneumothorax is the recognized primary collapse treatment of choice. Selective extrapleural thoracoplasty ranks second in our hands. Phrenicectomy places third, with its varied procedure and application.

DISCUSSION

DR. LOUIS FRANK, Louisville, Ky.: I have a feeling that this is a field that is still open for considerable development. We do not see so many of these cases requiring rib resections but we have a few. We have done 25 thoracoplasties. Of this number one patient died as the direct result of the operation, mediastinal shift. Our final results are considered from the standpoint of the disappearance of tubercle bacilli from the sputum and the patients' ability to resume their usual activities and evaluated upon this basis our recoveries are about 35 per cent. We have eight of the twenty-four surviving who are actively engaged in their former usual occupations. I would be interested in hearing just what the end-results in this series were, whether all patients made recoveries with disappearance of the bacilli from the sputum and ability to resume their activities.

We have done no resections of the type Dr. Johns spoke of, taking out only the upper ribs. We have taken out ten or eleven ribs and in most instances have done this in two stages, taking out the lower ribs at the primary operation. We found in one of the first cases we treated that in the lapse of time between the two stages the upper ribs had regenerated to such a degree that it involved many difficulties. We found it more satisfactory to remove the lower ribs before the upper were attacked.

I believe there is a great future for this work, and one should not wait until the patient is almost dead before doing anything. The operation should not be considered as absolutely the last resort but should be undertaken as soon as it is demonstrated that the less radical procedures do not bring about the desired collapse. We very much question the possibility of securing the necessary and desired collapse by the plan advocated.

Dr. Frank K. Boland, Atlanta, Ga.: My work has been somewhat similar to Dr. Frank's, in that we have not been content with resecting the upper ribs but do a complete thoracoplasty in two stages. However, the work of Dr. Johns appeals to me. If the lower portion of the lung is in good condition, why collapse it? The patients need all the breathing space they can get and if we can stop the disease by this operation that should be sufficient. However, as Dr. Frank said, we cannot wait too long between the two stages if we do the complete thoracoplasty, for if we wait longer than ten or twelve days there is so much fixation from the upper operation due to regeneration of bone that we do not get as thorough a collapse as we would if we operated within ten days or two weeks after the first stage.

I think it is important not merely to excise the ribs but to be sure that there is a good collapse of the lung. In one case, after excising suitable segments of the upper five or six ribs perfect strapping of the chest was not done and a roentgenogram later showed that very little collapse of the lung had occurred. The ends of the ribs were standing out as they had at the time of operation because there had not been proper strapping of the chest wall following operation. I think this feature should be given attention. Dr. Lilienthal has advised the use of an elastic adhesive plaster that is very excellent for this purpose for it holds the chest wall down and at the same time does not embarrass the respiration. I think it important that we have fixation of the diseased lung by scar formation before we attempt extrapleural thoracoplasty, for if we do not we are likely to collapse the heart also. We have had two deaths in these cases which I am sure were cardiac deaths and not pulmonary, because the heart was collapsed as well as the lung whereas if the lung had had sufficient fixation by scar tissue collapse of the heart would not have occurred. I think the operation should not be done if the trachea is in the midline. As emphasized by Archibald, the trachea should be drawn to one side before the operation is undertaken.

Dr. George H. Bunch, Columbia, S. C.: I think there is a field for partial thoracoplasty as advised by Dr. Johns. With a cavity in the apex if there is not much involvement of the lower portion of the lung I think this type of procedure is indicated. We have had difficulty in being sure that these cavities are collapsed even after the removal of the ribs over the apex. In one such case we packed the wound with vaseline gauze so as to induce sufficient pressure on the apex to insure emptying and collapse of the cavity. That patient did very well and the sputum is free from bacilli today, but we had the unfortunate complication of an empyema in the lower pleural space. This, however, after drainage healed and the result as a whole I think is satisfactory.

Dr. Frank S. Johns (*Closing*): The limited type of operation which is the subject of my paper is only suitable for cases with apical involvement, and I am not to be understood as advocating it for cases with involvement of the middle and lower lobes. That is why we have clearly termed it a "Selective Collapse" operation. If a lobe is sound, we see no reason to compress it by resection of the ribs. Furthermore, this operation if on the lower lobe carries a higher mortality than the results of upper thoracoplasties, due, in part at least, to pressure on the great vessels and on the heart. In our experience, compression for apical lesions has thus carried a more favorable mortality than our basal collapse therapy. In our early thoracoplasties, we always followed out the complete operation, in two or more stages, resecting the lower ribs first, as advocated by Sauerbruch. But our work in recent years has shown us the definite advantage of the selective or limited operation.

Dr. Boland, in his discussion, emphasized the necessity of waiting for the fixation of the mediastinum with these patients. I may add that all of the cases referred to in this paper have had hospitalization for at least two years, and were to be termed advanced cases before operation. Hence, they had of course reached a fixation of the mediastinum.

The only difficult part of this operation is the resection of the first and second ribs. The operation on the lower lobes is easily done. But in certain apical cases we have had equally good results and a lower mortality with our limited operation.

My plea is that we try to get such patients earlier. I am convinced that many patients remain in the hospital too long under expectant treatment before they are referred for surgical consultation.

I believe that the selection of cases is responsible for our results, and that close cooperation between the surgeon and the internist trained in pulmonary tuberculosis is essential.

In reply to Dr. Frank's inquiry as to the number of our cases still having positive sputum after operation, our records show this to be true in less than 7 per cent of our selective collapse cases.

PREVENTIVE SURGERY

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SINCE 1850 the medical profession has made remarkable strides in knowledge of disease; its cause, its prevention, and the newer methods of treatment. Progress has been especially great during the last fifty years.

I would like to dwell, for a moment, on certain factors in this progress. There is a marked interrelation of the sciences, and sometimes the conservatism of one branch, usually a praiseworthy quality, causes some truth to be rejected for many years. The science of optics had made possible the magnifying of the minute, and microbic life, which had motility, had been recognized for 200 years before Pasteur's time. Several papers on this subject had been presented, showing that microbic life was not all motile, and that microbes were probably the cause of some special diseases, but this knowledge made no impression either on the medical profession or the public until the time of Pasteur. Pasteur set the stage for his investigative work and convinced the public of the merit of his experiments before their acceptance by the medical profession; thus, the profession of that period was pushed from behind, rather than leading. Then, Lister, in his recognition of Pasteur's work, modernized surgery along antiseptic lines, which were later applied in the development of aseptic methods.

This bit of history illustrates that of the several factors connected with prevention of disease, one of the most important is education of the public. If we fail to have public opinion to support the rather loose laws that have been established to control public health work, we can accomplish little by law enforcement.

Development of public health made rapid strides through the appointment of city health officers and state health officers,

and through the establishment of national services for the protection of interstate health activities and for the protection of our extensive coastline against the transmission of disease from foreign countries. The school physicians, school nurses, school dentists and the trained athletic instructors rapidly have made our people health conscious, and as a result the life span of man has been advanced to approximately fifty-eight years, a gain of eighteen years in three-quarters of a century. This has been accomplished largely by the prevention of contagious and infectious diseases of childhood, and a considerable element in prevention of these diseases has been the use of pasteurized milk. Preventive medicine has almost reached its maximal effectiveness in the control of disease in the gross, and with increased knowledge individuals are coming to realize that further prolongation of life must come through individual effort.

From the viewpoint of public health and considering that surgical diseases occur in waves of exacerbation and diminution occupying one or two decades, it is evident that education of the public must be constant. Moreover there are new generations constantly coming to the age when they are susceptible to special diseases, and to the diseases which are seasonal in their appearance. Thus, in the early spring we have infections of the respiratory tract that lead to empyema, and early recognition limits the amount of surgery required.

When does disease begin? Physicians can diagnose and care for disease only as the people, aware of their own trouble, or of the trouble of their children, seek examination. Too often they call in the physician very late, for many diseases are painless. When the patient first comes to the doctor the early symptoms are often regarded as trivial, although they are really warning symptoms, and when next the patient comes the disease is far advanced. If the primary trouble was referable to the gallbladder, with gas and indigestion, the patient may next return in an attack of gallstone colic, or with jaundice. If we could but recognize disease in the early stages,

and prevent the progressive destruction, surgery might be avoided, or limited to a slight procedure instead of an operation of sacrifice being required.

For more than a decade the medical profession has discussed health examinations, the yearly birthday examination for those of middle age and more. There are few of us trained today in examination of well or apparently well persons, and we see the early trivial evidence of bigger things. Inasmuch as cysts on the uterine cervix have not, in every case, produced rheumatism, arthritis of the neck or fingers, or recurring diseases of the eye, it is easy to say that they amount to nothing, or in examining and treating recurring diseases of the eye, or rheumatism of small joints of the hands and feet, it is easy to neglect examination for painless infections of the prostate gland, or of the uterine cervix and to fail to examine for foci of infection in the mouth, because these structures are not in our line of work. The foci, then, of both men and women, continue to feed infectious material into the blood stream, and this material has definite predilection for certain regions, a characteristic which may have been maintained since the early animal life of the world, when most of the activities, beyond securing food, were associated with reproduction; prehistoric animals had diseased teeth and jaws.

Many persons do not seek a health examination until some sickness, usually painful, makes medical attention necessary. It would seem that there must be no let-up in public health work; lectures, infant welfare, child welfare, maternal health protection, and care of the expectant mother and child. The combined result of this work in the past has advanced the age of man largely by saving the lives of babies and children. Now, more and more old people are dying of degenerative diseases and of malignant disease. Malignant disease does not begin as a malignant cell, except in metastatic growths, after the original tumor has become malignant and has sent its cells throughout the body by means of lymphatic

channels and the blood stream. It is better to remove an adenoma of the breast than an advanced carcinoma. That means that all people must pay greater attention to their skin. Black moles on the skin are always a danger, and if they are raised above the surface they are a greater danger. Black moles should be removed, because, when they become malignant, they are the most malignant of cancers and metastasize very early if they are not removed on suspicion that a change in them is noted. People must also pay attention to unnatural functional activities, and they must double their precautions against the diseases that their parents died of, cancer or other conditions, for we do inherit cellular weakness.

THE EYE AND THE UPPER PART OF THE RESPIRATORY TRACT

During many years of surgical work, before surgical specialism had advanced along such narrow lines as are now maintained, I had the opportunity to see many abnormal conditions which were caused primarily by infections, or by mechanical factors, and they did not only cause the abnormal conditions but caused them to progress. For instance, hypertrophied adenoids changed the form of the face, caused aural and nasal disease, and led to destruction by infection as the disease progressed. I have, therefore, taken for presentation some of the conditions in which minor surgery at the opportune time prevents major surgery at a later date, with the risk of loss of function, or even loss of life.

For many years I had charge of surgery of the eye, ear, nose and throat in our clinic. I recall now the serious cases of infection of the middle ears of children, with extension to the forming mastoid cells. The history would be that the trouble had started with mild disease of the tonsils and adenoids, that there had been recurring attacks, and that in the present attack the child had suffered with earache for more than twenty-four hours without any discharge coming from the ear, or if discharge came there was no relief of pain.

The infection had passed into the mastoid, and sufficient change had not developed in some tough and thickened membrana tympani to cause spontaneous rupture. Severe earache of children is often relieved by the osmotic effect of warm glycerin applied in the first few hours; if this does not serve, the membrane requires a proper incision to relieve tension and while infection is in an early stage, inflammation of the mastoid is usually not in a surgical stage.

There are two types of acute mastoiditis, the hemorrhagic and the suppurative. In the hemorrhagic type it is important that the mastoid be opened early in the course of the disease because of the danger of acute thrombophlebitis of the veins in the mastoid cells. The disease must be relieved before the intracranial sinuses are involved. High temperature of little children is evidence that osteomyelitis has begun.

Children often have acute tonsillitis which causes extreme depression. Possibly acute rheumatism develops, with endocarditis, but apparently they recover, the tonsil remaining large. The doctor may discover, six months later, that endocarditis has caused deformity of one or more valves. Here preventive surgery, removal of large tonsils of children, would be really preventive medicine. Moreover, the large tonsil is often the source of pressure on the eustachian tube, which prevents ventilation of the ear. I think the tonsils were of great benefit to man in his development from uncivilized to civilized life, for they kept the mouth well filled with wandering leucocytes, which helped to protect him against disease. Today there are some good tonsils, but there is an enormous number of bad tonsils, which, if kept in the throat, are a constant menace. They distribute germs through the blood stream to other regions of the body; these other regions receive treatment, and the tonsil is overlooked as a source of recurring attacks.

The mouth long has been recognized as a hot bed of infection. Several types of organisms are always present; some of the neuropathic varieties, which are air-borne and lodge in

the pharynx, are the cause of acute neuropathic conditions. Other organisms, lodged in pyorrheal pockets, root abscesses, or tonsillar crypts are the cause of a number of recurring and chronic diseases, certain cases of rheumatic pains in the muscles and joints, and chronic and recurring diseases of the eye. Foci of diseases of the eye, we know, are the chronic uterine cervix or the prostate gland or the mouth in a high percentage of cases; similar foci in domestic animals would cause disease of the olfactory organs rather than of the eye; both are sexual relationships.

THE ABDOMEN

Last year in the United States there were 25,000 deaths from appendicitis. Fishbein has stated that 20,000 of these patients should have been saved. After Fitz first described appendicitis the subject was rapidly taken up by the great surgeons of the period, McBurney, Deaver, Murphy, Ochsner, and a host of others. Early operation was accepted as desirable, and yet many deaths from delayed operation occurred in those cases in which a cathartic was given, stimulating the advance of appendicitis and early rupture. There was almost no mortality among patients who underwent operation in the first twenty-four hours, but there was an increasing mortality rate with each day thereafter. Subsidence of appendicitis is never to be looked on as evidence of cure but only as evidence of remission, and there will be further attacks, or secondary trouble, from influence on the sympathetic nervous system as long as the appendix remains.

The medical profession is not doing so well at this time in stirring up the public to early recognition of symptoms of appendicitis as was done two decades ago, when Murphy, Senn, Deaver, Morris, and a host of others were forcing the discussions on the subject of appendicitis in papers and at every medical meeting. A few years ago discussions on the subject were rare, and now the high death rate again is showing the need of developing renewed efforts to educate the public

to the safety of early operation, with almost no mortality, as compared with the dangers of delay. The appendix, as a trigger of disease, works through the sympathetic system, in one case on the gall bladder, and in another on the pylorus by causing chronic spasm of the smooth muscle of the outlet of the common bile duct, or pylorus, or both. One progressive disease may begin as chronic appendicitis, and gradually there may develop hepatitis, biliary tension and enlargement of bile ducts, cholecystitis, and finally stone, papilloma, or degenerative lesions of the mucous membrane, in some cases aiding the development of ulcer of the duodenum or stomach.

Acute ulceration of the stomach or duodenum, with hemorrhage, may be concerned with an active focus of infection that is under tension in the mouth. I believe the appendix is a far greater offender than it has been credited with being. Many minor attacks sufficient to stir up the sympathetic nervous system, and yet not to the extent of making local symptoms intense enough for operation to be urged on the patient finally result in acute appendicitis or obliteration of the appendix; however, by that time other diseases, especially in the upper part of the abdomen, affecting the stomach, duodenum, liver or gall bladder, or the colonic spasms which result in diverticula may have advanced to a stage at which they are apparently of primary origin. In both children and adults, the less serious but recurring troubles of the appendix are the cause of some people being affected by digestive and hepatic functional diseases.

Infections in the appendix are common. Sometimes the infection is acute and is accompanied by spasm of smooth muscle, closing the outlet of the appendix. Then drainage is poor, and material is retained to form concretions. The spasms may work back from the tip of the appendix in some cases, and ultimately such an appendix will undergo obliteration. Constantly some infected material is in the appendix just as such material is in the intestine. If an appendiceal concretion is suddenly caught in a ring of muscle which is in

spasm, acute appendicitis is the result; the concretion may slip out before the necrosis and perforations occur, and that, for the time, terminates the attack.

During the last few decades intensive study has been made of the liver, its function, its diseases, diseases of the bile ducts and of the gall bladder. In the early stages of disease of these structures persons may have trouble, but it is not serious; diet and laxatives give relief. The liver has such marvellous powers of regeneration in the intervals between the attacks of gas and indigestion that we are surprised at how well it looks when exploration finally is carried out. I believe that the gall bladder, and the sympathetic nervous system surrounding it, have marked control over the tension at the outlet of the common bile duct. The liver must take up all of the portal blood, and it receives an enormous number of bacteria. The slowness of the movement of blood passing through the liver gives the hepatic cells a chance to destroy the bacteria. In the course of operations on the gall bladder, Judd took small sections of the margin of the liver away from the gall bladder, and found that 27 per cent of these sections, when ground and cultured, contained bacteria. An enormous proportion of this great structure must contain germs in process of destruction. There is wide variation in the tension of the common ducts of animals which have gall bladders; very low tension in those which have no gall bladders.

In the early days we depended on the clinical evidence of disease of the liver and gall bladder, and in removed gall bladders we found thin or thick bile, and sometimes small stones that we could not palpate and that could not be shown roentgenographically. The roentgen rays gave evidence of stones only if they were composed of materials through which roentgen rays could not pass. Thirty-six years ago we were able to detect stones in approximately 70 per cent of cases in which they were present. Marked advance has been made in roentgenology of the gall bladder since Graham brought out his dyes, and a few expert roentgenologists are able to

detect the presence of papillomas of the gall bladder. However, I believe that we have grown to depend too largely on the laboratory, which should be employed to confirm or controvert a diagnosis; not to make one. If laboratory evidence is allowed too prominent a place, it may prevent the surgeon giving due weight to the clinical evidence furnished by a carefully taken history and examination of the patient.

Except for cholesterol stones, which often form quickly as they do in pregnancy, and results of the presence of which are often mechanical only, I believe that the presence of gallstones should be considered as evidence, not of the first stage of the disease, but of the fourth. First comes hepatitis; second, spasm of the outlet of the common bile duct, with distention of the biliary tract; third, cholecystitis, from overwork of the gall bladder, excessive filtration of fluids, and retention of more salts and pigment that can be maintained in a fluid state by the colloids, and fourth, the development of stones. The later changes of the disease are largely mechanical and follow obstruction from the presence of stones and resultant diseases of the common bile duct and pancreas. I believe many surgeons have dropped back thirty years in their care of diseases of the liver and of the gall bladder, waiting for the laboratory to furnish evidence of the fourth stage of the disease. I believe that now there are more cases than formerly in which the edge of the liver is round, the liver itself is hard, and the ducts are dilated. Waiting for stones to form, and for roentgenologic evidence of their formation, is not preventive surgery. Preventive surgery in these circumstances would consist of removal of the gall bladder, giving relaxation of biliary tension. I know of no other way to prevent late and perhaps serious effects than to operate when the history and the physical examination indicate that operation should be performed. Delay leads to more cases of gross disease, jaundice, stones in the common bile duct, and carcinomas of the liver, beginning in ducts, than would be seen if the early condition had only been relieved by application of preventive surgery, safely accomplished.

The walls of 48 per cent of gall bladders in which there is evidence of disease give positive cultures. Sometimes the liver cannot destroy all the bacteria which are given to it to destroy. Then the kidneys may become involved, because they are under the necessity of eliminating more bacteria than they are capable of eliminating. Rosenow has shown that the organisms which can be cultured from diseased gall bladders, when injected into animals, have, in fairly high percentage, predilection for localization in the heart muscle. This is perhaps but one of the reasons for the increasing proportion of sudden and unexpected deaths from heart disease in middle and later life.

Diverticula of the colon, resulting from spasm that accompanies peristaltic action, give opportunity for development of small sacs in its vascular spaces. These sacs become culture tubes for bacteria which have found foothold in the body in early life; the infection may have started in the mouth, teeth, or tonsils, and some particular variety may adopt the body as host, living in the body and by it, the long period of training having attuned the microorganism to its soil, or often having changed the soil to suit the microorganism. The green-producing streptococci, as well as other streptococci, are very serious invaders. They are on hand when depression in health and lowering of temperature occur, and quickly produce recurring disease of the lungs, heart muscle, or blood vessels.

Postmortem examinations disclose that acute or chronic infections cause a break in health, lowering of resistance, and finally 86.5 per cent of deaths of human beings.

THE UTERINE CERVIX

In cases in which subtotal hysterectomy is performed, it is well to adopt, if possible, the added technique of cupping or coning out the cervix, to the vagina, particularly if the women have borne children or if there is any suspicion that foci of infection are present. It is appreciated that the degenerating, non-resistant cervix may possibly become a chronic focus of infection resulting in an apparently new disease at some distant

point. Moreover the cervical tissue may at any time become malignant; cancer developing in the cervix following subtotal hysterectomy is usually not diagnosed until the disease is far advanced, and although treatment may prolong life, cure is rarely obtained. A review of cases seen in our clinic reveals that between January 1, 1910 and July 1, 1930, 99 patients who had undergone hysterectomy presented themselves with carcinoma of the cervical stump. In one of these cases carcinoma developed twenty-nine years after subtotal hysterectomy had been performed.

In 15 of the cases the hysterectomy had been performed at the clinic; in 12 cases for benign conditions and in 3 for questionably benign conditions. In 84 cases the hysterectomy had been performed elsewhere; in 23 cases for benign conditions and in 61 for questionably benign conditions.

The low incidence of carcinoma of the stumps of the cervix in cases in which subtotal hysterectomy was done at the clinic may be attributed to the frequency with which, for many years, the technique of cupping or coning out the cervix has been employed, thus removing all of the cervical canal.

THE VALUE OF THE OLD AND THE NEW

Follow-up surveys, and the growing approval with which the profession and the public are regarding exploratory operation are favoring the application of what I have here termed "preventive surgery." Not all of our refinements in methods of diagnosis are favoring it, however. I would not minimize the value of any one of the really marvellous diagnostic procedures we now have. Rather, I would say, let us use them all, to the limit, but let us not, because of that, minimize the value of clinical judgment. And as an illustration of exactly what I mean I am going to repeat myself: Gallstones, the presence of which can be definitely demonstrated in association with disease of the biliary tract, represent the fourth stage of the disease. Early operation in suitable cases can prevent this fourth stage ever developing.

ARACHNIDISM

LLOYD NOLAND, M.D., F.A.C.S.

BIRMINGHAM, ALA.

AN apology may seem in order for the presentation of such a subject before this Surgical Association, but our conviction that the condition is frequently unrecognized, may easily be mistaken for an acute surgical abdomen, and that in all probability the occurrence of such cases is on the increase, is, we believe, sufficient excuse.

Emil Bogen of Los Angeles has published several classical papers on this subject, one of which, the California Medical Association Prize Essay for 1926,[1] is freely quoted hereafter.

Latrodectus mactans is certainly the chief, and is perhaps the only really poisonous spider in the United States. This spider is shiny, coal-black, usually brilliantly marked in red or yellow, or both, the most constant being an hour-glass-shaped bright red marking on the ventral surface of the abdomen. The female, always the one responsible for the bites, may attain a half inch in length, with a leg spread of as much as 2 inches.

This spider is variously known to the public as the "black widow," the "hour-glass" spider, the "shoe-button" spider, the "T bar" spider, the "po-ko-moo," and the "poison" spider. Its habitat is the southern half of the United States, from the Pacific to the Atlantic, although its occurrence has been reported as far north as New Hampshire.

The "black widow," so-called because of its custom of eating its mate, is usually found alone. It builds a coarse web in dark or dimly lighted places, the seats of outdoor toilets seeming to be frequently favored, but instances are increasing of its invasion of habitations, garages, automobiles, and even

[1] *Arch. Int. Med.*, Nov., 1926.

of beds in which persons are sleeping. This spider is seemingly fearless, instantly attacking anything coming near it.

Bogen states that more than 150 cases of poisonous spider bites had been reported by 33 physicians in the United States during the last century prior to 1926, two-thirds of which occurred in California. Cases were reported, however, from Florida, Virginia, Georgia, North Carolina, Alabama, Texas, Oklahoma, Maryland, Pennsylvania, Tennessee, Ohio, West Virginia, and Arkansas.

In an eight year period, 1924–1932, 29 cases of arachnidism have been admitted to the Employees' Hospital at Fairfield, Alabama. Of these cases 24 were males, and 5 were females. The age instance was from eight to fifty-three. Fourteen were negroes, and 15 were whites. In 20 of these patients the bite was received on the genitals; in 9 on other parts of the body, such as leg, finger, hand, knee, etc. In 17 cases the bite was received in an outdoor privy; other bites were received variously, such as in a garage, in an automobile, 2 in bed, 2 in the field, 2 in houses, etc.

In every one of our cases the symptoms have presented a most dramatic picture, of which the following is an instance.

J. T., negro, male, aged forty-three, admitted with a diagnosis of acute intra-abdominal lesion, probably perforating ulcer. History was as follows: About 3:00 A.M. the patient, as a result of a large dose of epsom salts, found it necessary to go to an outdoor toilet, where he thinks that something bit him on the scrotum. About five or ten minutes later he began to have very severe pain in the right thigh. The pain progressed to involve the lumbosacral region, the hips, the entire abdomen, and the right chest. The patient was admitted to the hospital about three hours following the beginning of the attack. He had been given a hypodermic of ⅙ grain of morphine about one hour before admission. The picture presented was one of intense agony, the patient complaining of terrific pain in the abdomen and back, the hips and both thighs. The abdomen presented an intense board-like rigidity. Temperature 98°F. Pulse 90. Urine showed a trace of albumin. Leucocyte count was 8000. Blood pressure 140/90. The pain was so intense that the statements of the patient were decidedly incoherent. A bite could not be discovered. About two hours after admission the temperature rose to 100°F., descending to normal in about six hours and

remaining normal for the following twenty-four hours. On the third day the temperature again rose to 100°F., but subsided within a few hours. The patient was given four doses of 1/6 grain of morphine over a period of about six hours before any relief was obtained. His complaint of intense agony was continuous, and it was difficult to keep him in bed. The abdominal pain was markedly paroxysmal. There was no vomiting at any time. The patient gradually improved, and at the end of seventy-two hours had entirely recovered, except for some muscular soreness.

The picture presented above is typical, the most outstanding symptom being the intense pain and the absolute board-like rigidity of the abdomen. Most of the cases sent to the hospital have been diagnosed as acute abdomen before admission. We believe that a picture such as that here presented, closely simulating the intense, agonizing pain frequently encountered in perforated gastric or duodenal ulcers, can very easily indeed lead to serious mistakes in diagnosis and to the performance of abdominal exploration. Differentiation should be comparatively easy in most instances if one is informed and familiar with spider poisoning and considers the intense cramp-like pains practically always encountered in the extremities and the back, as well as a history of possible spider bite, and not infrequently one is able to locate a small punctate indurated area at a point where the bite was received. None of the patients in our series has been operated on and all have recovered in periods varying from twenty-four to seventy-two hours. There has been nothing unusual in blood pressure readings, although on the whole they are rather elevated. The leucocyte count has varied from a high of 26,000 to a low of 6000, with an average of 11,000. There has been retention of urine in only 3 cases of the 29. In no case has temperature elevation been noticeable, most cases remaining practically normal, with an occasional rise to about 100°F. The majority of cases have shown negative urine. In most cases there has been some increase in pulse rate, with an occasional case showing a marked decrease. Treatment has been purely symptomatic, consisting in the main of hypodermics of morphine, many requiring a very heavy dosage,

with repeated assurance to the patient that he will recover. In most instances it has been difficult to convince one of these victims that he is not at the point of death, and in several cases repeated appeals have been made for some lethal drug to end the unendurable agony.

DISCUSSION

DR. WALLER O. BULLOCK, Lexington, Ky.: Until recently the disease of arachnidism had never been definitely proved. Comstock, an authority on spiders in this country, in the earlier editions of his work does not report a single instance of death from spider bites, and I think none up to the present time. The subject is well worth presenting.

DR. KENNETH H. AYNESWORTH, Waco, Texas: We had 5 cases of arachnidism in the hospital the summer before last. In one instance the patient was sent in as suffering from an acute abdomen and the physician wished me to operate. One of the internes examined the patient carefully and diagnosed an acute surgical abdomen. When he telephoned me the symptoms, I told him to get another interne to examine the patient; this interne diagnosed the ailment as an acute spinal lesion.

The differential points were these: The patient, a negro, had been working in the cotton field and had not had a bowel movement for two days. He took a dose of salts in the afternoon and about two o'clock went to an outside toilet. While sitting there he was bitten on the scrotum; the pain was slight, but he scratched the place. About twenty minutes later he went to the house, vomited a number of times and was writhing with pain. A physician was called who gave him morphine, examined him and sent him to the hospital thirty-five miles away. When I examined the patient, he was apparently critically ill. The abdomen was board-like all over, but the patient was restless, indicating that it was not an inflammatory lesion. Also, he complained of pain in the thighs and in the chest. After going over him carefully we made a blood count and found moderate leucocytosis, a moderate increase in the differential count and the temperature somewhat increased. Due to the fact that the pain was in the distribution of the spinal system in the chest, the abdomen, thighs and legs, we ruled out an abdominal lesion. The pains were not paroxysmal or colicky. Then we ruled out the question of an inflammatory lesion of the intestines. No areas in the abdomen were tender to pressure; he had vomited, he had a slight rise of temperature, and an increased white cell count, but we could not find any mass, so we felt that it could not be an inflammatory lesion or obstruction of the intestinal tract. Then we agreed with the interne that it was a spinal nerve affair. Just at that moment the patient said, "the

black widow bit me." Then I looked it up in the literature and found an exact picture of the case. The patient was not operated upon.

Within a month 4 other similar cases were seen and the "black widow" was very popular with us at that time. We held a staff meeting on the subject and reviewed all the literature available.

Dr. Barney Brooks, Nashville, Tenn.: I have had an opportunity of observing a few instances of the remarkable effects of the bite of poisonous spiders. In a recent instance, an observation was made which may be of significance. The patient was a young boy who suddenly developed intensely severe abdominal pain. The first physician made a diagnosis of perforated duodenal ulcer. Because of the history of a previous penetrating wound of the foot and extreme abdominal rigidity, the second physician made a diagnosis of tetanus. On examination the abdomen showed the presence of muscle rigidity to the point of almost stony hardness. It was observed, however, that in spite of the intense abdominal rigidity, respiratory movements were not completely suppressed. It is possible that this may be a constant difference between the clinical findings in arachnidism and those associated with acute general peritoneal irritation.

Dr. J. M. Mason, Birmingham, Ala.: It is very interesting to note how closely the symptoms of arachnidism simulate acute abdominal infection. It seems to me that the observation of Dr. Aynesworth calling attention to the fact that the widespread pain and rigidity are symptomatic of spinal irritation is very important. This should always be borne in mind when one is called upon to make a differential diagnosis.

In the presence of severe abdominal pain and leucocytosis, the patient who is suspected to be suffering from arachnidism should be kept under careful observation for a sufficient length of time to be sure that no inflammatory abdominal disease is present.

Dr. Lloyd Noland (*Closing*): I am particularly glad that Dr. Aynesworth and Dr. Brooks have brought out the point that in spite of the terrific rigidity of the abdomen, there is little or no tenderness. This, I believe, is a most important point in the differential diagnosis.

ACUTE EXTRADURAL ABSCESS WITH COMPRESSION OF THE CORD

GEORGE H. BUNCH, M.D., F.A.C.S., AND EMMETT MADDEN, M.D.

COLUMBIA, S. C.

ALTHOUGH he had never had a case of his own we are indebted to Dandy for a study of the 25 cases of acute epidural abscess reported in the literature up to 1926. Of these only four were operated upon, of which 2 recovered, and 21 patients died without the benefit of surgery. Three followed trauma; 10 were metastatic from furuncles or other foci of infection and the remaining 12 cases were not classified as to origin. Dandy makes the significant statement that largely because of anatomical limitation, infection whether acute or chronic seems to occur (1) only in the spinal epidural space, (2) only in the dorsal half of the spinal canal, and (3) principally in the thoracic region.

Preceding trauma by lowering local resistance is an etiological factor in a definite percentage of cases of epidural abscess. Many cases follow furuncles or other foci of infection and are metastatic in origin. Indeed, except where there is direct extension from local infection, even though a focus is not found the organism must come by the blood or lymph stream. Of infecting organisms Staphylococcus aureus has been found most often in the pus.

Acute epidural abscess manifests itself by girdle sensations, tenderness and pain in the back and legs which may become intense. With these there are the malaise, fever and leucocytosis of acute systemic infection accompanied by rigidity of the back and neck. The condition is rapidly progressive and in a day or two there may be beginning sensory and motor paralysis of the lower extremities which soon develops into paraplegia from the constantly increasing pressure made upon the cord by the enlarging abscess. The paralysis may be spastic or flaccid in type. Damage to nerve tissue is caused

not only by the degree but also by the duration of pressure. There is incontinence and loss of sphincteric control of both bladder and rectum. Both our patients had bladder paralysis

FIG. 1. Case 1. Lipiodol injection three years after operation shows block at level of eleventh thoracic vertebra. Operation for relief of block advised but declined.

with acute retention. One was sent into the hospital to a urologist for cystoscopic study and had spastic paraplegia with staphylococci in the pus, following a furuncle; the other had flaccid paralysis, after recent trauma of the back, which became spastic sometime after drainage. There is often an area of hyperesthesia above the anesthesia level. Both are bilateral and rise as the abscess enlarges.

The diagnosis should be made early so that decompression and drainage can be done before damage to the cord is irreparable. The history of injury to the back, of furunculosis or other septic infection followed by pain and stiffness of the back and neck, fever and leucocytosis are quite suggestive. Neurological symptoms begin with root pain, increased tendon

reflexes followed by paraplegia and loss of sensation in the legs. The cerebrospinal fluid is often xanthochromic and although having increased protein is without material increase

FIG. 2. Case II. Lipiodol injection shows block at eleventh thoracic vertebra marking site for drainage of abscess.

in cell count. The Queckenstedt test is positive for mechanical block. Without primary bone infection *x*-ray findings are negative but examination when made with the patient in the Trendelenburg position after lipiodol injection into the lumbar region definitely locates the lowest level of spinal block so that operative relief can be accurately planned. Epidural abscess must be differentiated from spinal caries, meningitis, transverse myelitis, poliomyelitis, cord tumor, and after trauma from hemorrhage into the cord and from fracture compression. When the clinical picture is complete diagnosis should be easy but in the early stages of the disease recognition is difficult.

The treatment of epidural abscess is laminectomy and drainage as soon as the diagnosis has been made or is suspected. The epidural space is continuous through the thoracic region and when suppuration occurs pus soon fills the space and extends from the block below to the cervical region above. In our opinion adequate dependent drainage can be had by the removal of 2 or 3 laminae at the lowest portion of the abscess. It is unnecessary and unwise to attempt the removal of laminae throughout the length of the abscess. The dura is tough and resistant so that meningeal or cord infection is a late complication. After the laminae are removed a layer of epidural fat must be penetrated before the pus is reached. The dura should be scrupulously protected against injury. Although both our cases were done under ether we believe local infiltration with novocaine may be the anesthesia of choice in these acutely ill paraplegic patients.

The condition has a high mortality. The outcome depends upon the virulence of the infecting organism, upon the resistance of the patient and last but by no means least the time of operation. Early drainage gives the patient his best chance of recovery without complication. We have found no case treated expectantly that has recovered. Craig and Doyle, Jan. 1932, found 14 cases of metastatic abscess fn the literature with only 1 recovery (case of Pulverenti). It was one of 3 cases in which operation was performed. They report a case of their own with recovery after operation making 4 cases of metastatic infection in which drainage was instituted with an operative mortality of 50 per cent.

Not including the cases studied by Craig and Doyle we have found in the literature since Dandy's report of 1926 17 additional cases of acute pyogenic extradural abscess which with 2 cases of our own make 19 cases. Of these, 3 patients were not operated upon and died. Of the 16 patients operated upon 4 died (25 per cent), 4 recovered with paraplegia (25 per cent), and 8 recovered completely (50 per cent). Of the 4 patients that died after operation 2 had cord involvement with soften-

TABLE 1

Reported by	*Age Sex*	*Origin*	*Location of Abscess*	*Symptoms*	*Operation*	*Result*	*Organism*	*Remarks*
Chiasserini	.....	.....	1st thoracic vertebra	.....	Laminectomy	Recovered	Staph. aureus	Lasted 12 days
Guttmann & Singer	F 21	Infected foot	Intra- & extradural abscess 9th thoracic	Pain in back, paraplegia, paralysis of bladder & rectum	Laminectomy 4th, 5th, 6th thoracic	Died	.....	Cord involved
MacDonald	M 2	Otitis media	.....	Spastic paraplegia	Laminectomy	Recovered	Staph.	
May	F 17	.....	.....	Flaccid paraplegia	None	Died	Staph.	Septicemia
May	.....	.....	.....	.....	Laminectomy	Recovered	Staph. aureus	
Pollak	F 24	Furuncle	.....	Paraplegia	None	Died		
Smitt	M 18	Face infection	4th thoracic	Flaccid paraplegia	Laminectomy	Recovered	Staph. aureus	
Veraguth & Schnyder	F	.....	2nd, 7th, 3d thoracic	Spastic paraplegia	Laminectomy	Recovered		
Allen & Kahn	M 25	Septicemia after appendectomy	4th thoracic to 1st lumbar	Pain in chest, flaccid paraplegia	Laminectomy 4th thoracic to 1st lumbar	Died, no necropsy	Staph. aureus	Died 15 days after operation
Allen & Kahn	F 15	Trauma	5th thoracic to 1st lumbar	Flaccid paraplegia	Laminectomy 5th thoracic to 1st lumbar	Died 8th day	Staph. aureus	Cord softened, meningitis
Allen & Kahn	M 30	Furuncle	4th to 11th thoracic	Flaccid paraplegia, loss of reflexes	Laminectomy 4th to 11th thoracic	Recovered paraplegia	Staph. aureus	Patient had retention catheter when reported
Mixter	M 18	Furuncle	3d thoracic to 1st lumbar	Paraplegia	Laminectomy 3d to 6th thoracic	Died, no necropsy	Staph. aureus	
Craig & Doyle	F 28	Cellulitis of nose	.....	Paraplegia	Laminectomy 11th thoracic to 2nd lumbar	Recovered	Staph.	
Ely	M 45	Carbuncle	7th thoracic	Paraplegia	Laminectomy	Recovered, spastic paraplegia	.....	Wound drained for weeks
Ely	M 27	Furuncle	Foramen magnum to sacrum	Paraplegia	None	Died	.....	Laminectomy not done because of paralytic ileus, necropsy showed pus from foramen magnum to sacrum
Ely	M 23	Furuncle	3d & 4th lumbar	Bladder paralysis	Laminectomy	Recovered	.....	Bladder control 48 hours after operation
Ely	F 21	Furuncle	3d & 4th thoracic	Paraplegia	Laminectomy 3d, 7th, 4th thoracic	Recovered, paraplegia	.....	Developed complete paraplegia after operation

ing; one had septicemia, staphylococci having been cultured from the blood, and no autopsy was obtained in the fourth case. So that 3 of the 4 patients dying after operation are known to have had lethal complications.

CASE REPORTS

CASE I. A white boy, W. C., aged eleven, had had the usual diseases of childhood. Both eyes had been operated upon for cataract leaving him with impaired vision. His present illness dated from his back striking a projecting root in a fall from a tree. After five days in bed his legs became paralyzed and he was admitted into the S. C. Baptist Hospital at 8 P.M. March 6, 1928.

Physical examination showed an acutely ill child with temperature 101°F., pulse 100 and respirations 32. His pupils were irregular with scarring about the iris. His chest was negative, and abdomen normal except for a distended bladder reaching to the umbilicus. There was flaccid paralysis of both legs with anesthesia and loss of sense of heat and cold to the level of the fourth lumbar vertebra. The cremasteric reflex was absent. There was incontinence of bowel and bladder with loss of deep reflexes of the lower extremity and tenderness in the thoracic and upper lumbar regions.

X-ray examination was negative except for an incomplete fracture of the body of the sixth thoracic vertebra.

The urine was normal. Leucocytes were 21,800 with 85 per cent polymorphonuclears.

Operation was done under ether anesthesia at 11 P.M., three hours after admission, and the laminae of the sixth to ninth thoracic vertebrae were removed. After a thin layer of fat was passed through about 1 oz. of white pus was found in the epidural space. The dura was not opened. The wound was drained with a rubber wick and closed.

Next morning the temperature was 104°F. but it soon fell and remained practically normal. On dismissal March 25, 1928 the bladder and rectum were incontinent. There was paraplegia with anesthesia below the waist. On April 20, 1928 the deep reflexes were exaggerated, sensation had returned to the legs but paraplegia persisted. On September 23, 1931 there was spastic paraplegia with sacral decubitus. The right knee was flexed from contracture. There was little if any control of bladder and rectum. *X*-ray examination after lipiodol had been injected in the lumbar canal showed incomplete block at the level of the 8th thoracic vertebra.

CASE II. V. C. D., aged eighteen, white, farmer. The family history was unessential. The patient had had no serious illness and was in excellent

health up to the present attack which began with pain in the back, weakness of the legs, and difficulty in defecation and voiding, two weeks after having had a large boil on the back of the neck. One week before admission into the S. C. Baptist Hospital, July 2, 1931, his legs became so weak he could not walk. He had numbness from the waist down and had to be catheterized.

Physical examination showed a temperature of 100.4°F., pulse 80, respirations 20. He was a well-developed young man complaining of pain in the thoracic region of the back. There was a slight swelling over the tenth and eleventh dorsal vertebrae with pain on deep pressure which circles around the upper abdomen. The rectal sphincter was relaxed. There was definite rigidity of the muscles of the neck and back. The knee and ankle jerks were hyperactive. Babinski, Oppenheim and Gordon reactions were positive. There was gross weakness of both legs but not complete paralysis. There was gross confusion to all stimulation with absence of pain from the level of the epigastrium downward. Above this was a narrow area of hyperesthesia. Spinal fluid was xanthochromic with increase of protein and cell count of 5. Fehling reaction was reduced. The Queckenstedt test was positive for block giving no rise of pressure upon jugular compression. The urine was normal except for pus cells. Leucocytes were 13,600 with polymorphonuclears 73 per cent and hemoglobin 80 per cent. Injection of lipiodol into the lumbar region and placing the patient in an exaggerated Trendelenburg position demonstrated complete blockage of the canal at the level of the eleventh thoracic vertebra.

At operation, August 1, 1931, under ether anesthesia, the laminae of the sixth to tenth thoracic vertebrae were removed. Thick pus was found filling the epidural space and continued to come from the space above after the five laminae had been removed. Dakin tubes were inserted and the wound closed. The pus contained staphylococci of an unidentified strain. Convalescence was prolonged but uneventful. The patient is now apparently normal in every way.

CONCLUSIONS

1. Acute extradural abscess is not as rare as has been supposed.

2. Accumulating experience proves it to be a recognizable clinical entity.

3. The only effective treatment is laminectomy with dependent drainage of the abscess.

4. Cases without complication, if operation is performed early, have less mortality than has hitherto been reported.

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DISCUSSION

DR. WALTER E. DANDY, Baltimore, Md.: I am sure these conditions are more common than statistics lead us to believe, although I have had only one case. In that case the patient recovered from the abscess but later died of metastases.

There are two sources of the abscess, one metastatic and one by direct extension; they are treated in the same way. I think Dr. Bunch's comment about the operative treatment is quite correct, the less one does the better. The establishment of drainage is essential and you can do that by removing one lamina as well as by more. These abscesses extend along much of the epidural space because there is no obstruction to their progress, and they extend so rapidly that no barrier is established by adhesions.

The diagnosis is not difficult. It is a spinal lesion plus the signs of infection. The one sign that is outstanding is the terrific, excruciating pain which is unrelenting and continuous. There is no tumor which will give such extreme pain. Dr. Bunch's results have been very good indeed. The block in the spinal canal is due to compression by the abscess. With early diagnosis and early drainage these patients can be spared the disastrous permanent complications which obtain if the condition goes on even a few days longer.

DR. PERCY L. DODGE, Miami, Fla.: Abscess of the spinal cord is an extremely rare condition and is practically always secondary to pus focus

elsewhere in the body. It is occasionally seen in virulent infections in the lung, septic endocarditis, kidney, and urinary tract infections, and may follow trauma by direct infection. It is accompanied by very acute pain of neuralgic radiating radicular character, chills and fever, rigidity of the spine, and tenderness on pressure and percussion. Diagnosis is the difficult part of this condition. Operative procedure is fairly easy after the diagnosis has been made. There are many recent aids to diagnosis. Lumbar punctures and particularly lipiodol are very important diagnostic aids. Where there is considerable pressure, we may find a positive Queckenstedt reaction. It is absolutely essential to operate in these cases immediately.

While in the New York State Hospital service, about 1913, an Italian woman was admitted on my service as insane, and a few days after was noticed to have a fever. A small lozenger sized swelling was found deep in the floor of the mouth. This was opened and about 2 drams of pus were evacuated. In a few days an abscess in the muscle tissue of another part of the body was opened. The case continued with abscesses forming almost daily, under the muscles of the calves, legs, thighs, abdominal recti, under the pectoral muscles, under the shoulder blades, back muscles, and even deep in the plantar structures. The wrist joints and knee joints were opened, and almost every muscle in the forearms was exposed and stripped of pus. The spine at about the eighth to tenth dorsal vertebrae was involved, which was opened, and an extradural or epidural abscess was found and evacuated. The last and final abscess was a psoas abscess which was evacuated through an incision in the groin from which two handfuls of greenish thick pus were taken out.

The patient then slowly and gradually got well, after a period of over three months of continuous operations. She recovered mentally and was discharged from the hospital.

AN ANALYSIS OF

COMPLICATIONS AND DEATHS OCCURRING IN APPENDICITIS

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THIS paper is supplementary to one read at the meeting of the American College of Surgeons in St. Louis in October, 1932.[1] That report was a general review of 3913 cases of appendicitis operated upon in the Union Memorial Hospital, Baltimore, from 1900 to 1930, by a total of almost one hundred different surgeons, including visiting surgeons and house officers; this report will limit itself to an analysis of the 91 deaths and 420 complications occurring in that same series. The same division into six general groups: chronic, chronic recurrent, subacute, acute unruptured, ruptured with abscess, and ruptured with peritonitis, will be followed. We will discuss first the deaths, then the complications. (The general distribution is best shown graphically in Table xxv.)

It is, of course, scarcely fair to charge all these deaths to either the appendix or the operation. All deaths are included which occurred during the hospitalization for the appendectomy, even though from such diverse causes as typhoid or scarlet fever developed during convalescence, tuberculosis, which was present before operation, a streptococcus septicemia apparently originating from a throat infection of similar etiology, present at the time of operation, or a carcinoma of the head of the pancreas which was readmitted six weeks after a cholecystgastrostomy with a ruptured gangrenous appendix trapped in the sac of a strangulated sliding hernia of the cecum. On the other hand, if we started to throw out deaths which to us seemed unrelated to the disease under discussion,

[1] *Surg. Gynec. Obst.*, 56: No. 2A, 360–366, Feb. 1933.

someone would be sure to accuse us, and possibly justly, of bolstering up our statistics at the expense of verity, even though we are not concerned with the actual percentage figures, except as an index for measurement within this particular group of cases. It means little to match one group against another; there are too many variable factors for any accuracy. Suffice it to say that our figures, as they appear, compare favorably with many others which have been published, whether they should be even better with judicious pruning will be left to your judgment.

By far the largest number of deaths was naturally due to the toxemia of peritonitis. In many instances it was difficult to determine how important a role intestinal obstruction played, the symptoms of the two being at times so similar. These formed the second largest group of deaths. The pulmonary complications loom large, though we have attempted to avoid listing as such the purely terminal pneumonias which are bound to occur, no matter what the underlying condition. The significance and frequency of embolic phenomena are probably masked under the term "pleurisy," but how to properly distinguish between the two in reviewing histories, often not very specific in their statements, we have not discovered. The cardiac deaths are surprisingly few, considering their relative frequency in vital statistics, and the fact that these approximately 4000 cases are the "run of the mine," entirely unselected. Also we were unprepared for the low incidence of pyelophlebitis and subphrenic abscess as compared with other series, and for which we have no explanation to offer. Then there are the other scattered causes, some of which were of peculiar interest: a child on the ward who contracted a cross infection of scarlet fever from a new admission (before the days of a probationary period of isolation, which now prevails), in the seventh week of convalescence from a peritonitis, and promptly died of the new disease; an appendiceal abscess developing in a patient during the second week of normal temperature following a severe typhoid and showing a pure

culture of that organism, while in another instance the growth from the pus in the lumen of an unruptured appendix was reported as pure typhoid several days before the typical symptoms of the latter disease made their appearance; 2 cases of acute appendicitis, one appendix already ruptured, occurring during the influenza epidemic of 1919 with leucocyte counts of 3000, both patients dying promptly of a massive pneumonia; and one patient with an unruptured appendix, transferred from a mental hospital for operation and dying on the sixth postoperative day, on whom a careful autopsy failed to reveal any adequate cause of death. There are other unusual cases worthy of special mention, but it would require too long a time to take them up individually. (See Tables.) Considering the figures as a whole, the most significant fact is the exceedingly small mortality risk attached to the operation per se, as shown by the figures in the first three groups. In these, where the inherent danger of infection from an acutely inflamed appendix is eliminated, we find but 2 deaths in 2106 cases, less than 0.1 per cent. Both of these deaths were in men of middle age, of short, thick, pudgy build, marked beforehand as relatively poor operative risks, and both of whom were subjected to a thorough abdominal exploration as well as the appendectomy, through a right rectus incision. Both followed the same postoperative course: a paralytic ileus, with progressive distention and total lack of peristalsis, dying after about a week with a terminal pneumonia. In each case the absence of a peritonitis was definitely proved, one by a secondary operation for enterostomy on the day of death, the other by autopsy. In view of the mortality rates in the more advanced groups, this certainly furnishes a potent argument for early operation, for no undue delay in doubtful cases, and even raises the question of the advisability, at times at least, of considering prophylactic removal. Another interesting point to which we have seen no previous reference, is the disparity in the mortality figures for male and female. Up to fifteen years of age they are approximately the same, in fact the female is slightly the higher.

Thereafter the male incidence is approximately two and one-half times the female; it would seem that the physiologic process of ovulation confers a certain immunity to, or unusual ability to take care of, peritoneal infection.

In reference to the complications listed in this series: Again we have included everything which occurred during the period of hospitalization, which might be construed as at all out of the ordinary, under the heading of complication. A great many of these could be in no way considered as dependent upon the operation. Some of the more obvious of these we have sorted out and listed as "Unrelated Complications." Many others not so included should rightly be under this heading; for instance most of the cases of tonsillitis, colds, and so forth, of which there are quite a few, really are in no way connected with the appendix or its removal. Then under those occurrences which are rightly attributed to the operation, a very large proportion appear as "Wound Infections," an ominous term. This is really not as bad as it sounds, however, as many of these were actually no more than slight superficial stitch abscesses in the skin sutures, or the breaking down and liquefaction of some of the adipose layer. One group is of especial interest, and we cannot help wondering if other surgeons have the same difficulty. In wounds closed with catgut, everything goes along fine, there is apparently perfect healing when the skin sutures are removed at the end of a week, no redness, induration, or tenderness in the wound. But somewhere between the tenth and fourteenth postoperative day a puffiness develops, a "blister" appears in the line of the incision, and opens with the evacuation of a considerable quantity of serosanguineous fluid, in which are many oily globules. These we have repeatedly cultured with a negative result. We have considered this as a reaction, possibly chemical, against the catgut, rather than as an infection, and have felt that it may play a definite etiological part in the predisposition to actual infections. For this reason, as well as for the greater strength which we believe it gives in the wound, we lean toward the use of silk, except

in the presence of actual infection, and call attention to the fact that only twice was subsequent removal of infected silk sutures necessary. Another interesting and surprising group is that of "Pregnancy"; in fifteen listed, with durations from "very early" to "seventh month," not a single abortion was noted. Several of these were drained cases, and one such required a secondary operation with formation of an enterostomy, for relief of an intestinal obstruction. There were 7 cases in which a Meckel's diverticulum was present; in most of these it was either removed or inverted into the bowel. There was one case of complete "situs transversus," which fortunately was recognized before operation, and three others of faulty or incomplete rotation of the large bowel, giving a left-sided appendix. There were 3 carcinomata of the appendix, one papilloma of the tip of the appendix, one villous papilloma of the body of the appendix, so large that it filled the whole lumen and extruded as a mass the size of a walnut into the cecum, and one diverticulum of the base of the appendix. There were 8 cysts, seven of the tip of the appendix, one of which was as large as a golf ball, and one in the center of the organ. In 3 cases the attack began immediately following direct trauma in the region of the appendix; in two of these an abscess was found at operation, the third was completely gangrenous. One appendix was 21.5 cm. long and over 2 cm. in diameter. The youngest patient was thirteen months, the oldest ninety years; both of their appendices were ruptured with peritonitis and they appear in the mortality tables. The average length of hospitalization in cases with complications was approximately twice that of those without.

So much for the general discussion. The following tables will show the analysis in a more graphic way.

TABLE I

CIRCULATORY COMPLICATIONS

Complications	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis**		*Totals*	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
Phlebitis, femoral	4	1	2	..	..	..	2	3	3	2	1	..	12	6
Phlebitis, saphenous	..	1	1	..	..	..	1	..	2	..	..	1	4	2
Phlebitis, pelvic	..	..	..	..	1	..	..	..	..	..	..	..	1	
Hemiplegia	..	..	..	..	..	..	..	..	1	..	..	1	1	1
Septicemia	..	..	..	..	..	1	..	..	..	1	..	..	..	2
Myocarditis—acute decomp	..	..	..	..	.	..	..	..	..	..	1	..	1	
Tachycardia	..	..	..	..	..	..	..	..	..	..	..	1	..	1
Totals	4	2	3	..	1	1	3	3	6	3	2	3	19	12

NOTE: In this and the succeeding charts of complications, a listing under the heading "Single" means there was but that one complication; under "Multiple," that that is one of two or more different ones. Thus a case with "Infection wound; phlebitis, femoral; embolus, pulmonary," would be listed three times, once under each heading, in the "Multiple" column.

* In this chart it is interesting to note the low incidence of phlebitis in the peritonitis group.

TABLE II
PULMONARY COMPLICATIONS*

Complications	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
Bronchopneumonia	4	1	..	1	3	..	7	..	3	4	3	4	20	10
Lobar pneumonia	..	..	..	..	..	..	..	..	1	..	2	..	3	
Pulmonary embolus	2	1	..	..	1	..	1	1	3	..	2	1	9	3
Pleurisy	5	..	1	1	..	..	1	4	4	3	2	..	13	8
Nasopharyngitis	1	..	..	..	..	..	..	3	2	1	..	1	3	5
Tonsillitis	2	..	2	1	3	1	2	..	1	1	1	1	11	4
Bronchitis	..	..	1	..	..	..	4	1	1	1	..	..	6	2
Influenza	..	..	..	..	..	..	1	..	..	..	..	1	1	1
Empyema	..	..	..	..	..	..	..	..	..	..	1	..	1	
Totals	14	2	4	3	7	1	16	9	15	10	11	8	67	33

* In this chart, many of the cases listed as "Pleurisy" were probably small unrecognized pulmonary emboli. In many of the "Nasopharyngitis," "Tonsillitis," "Bronchitis," and "Influenza" groupings, the complication was existent at the time of the operation, and hence was not really a postoperative complication.

TABLE III

ABDOMINAL COMPLICATIONS*

Complications	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
Secondary abscess—drained by operation	..	..	..	..	..	..	3	3	6	8	3	1	12	12
Secondary abscess—drained spontaneously	..	..	..	..	..	..	..	..	3	1	2	1	5	2
Fecal fistula—closed on disch	..	..	..	..	..	..	..	1	5	2	3	2	8	5
Fecal fistula—open on disch	..	..	..	..	..	..	..	1	3	3	2	2	5	6
Intestinal obstruction	..	..	..	..	..	..	..	1	4	2	4	7	8	10
Intestinal paralytic ileus	1	..	..	..	..	..	..	1	..	..	..	1	1	2
Subdiaphragmatic abscess	..	..	..	..	..	..	..	1	..	..	1	..	1	1
Jaundice	..	..	..	..	..	1	1	..	..	1	..	..	1	2
Gastroenteritis	..	..	..	..	..	..	1	..	..	..	..	..	1	
Neurotic vomiting	..	..	..	..	..	..	1	..	..	..	..	..	1	
Ischiorectal abscess	..	..	..	..	..	..	..	..	..	..	1	..	1	
Totals	1	..	..	..	..	1	6	8	21	17	16	14	44	40

* A few of the "Fecal fistulae" were spontaneous; many of them the result of enterostomies. Under "Paralytic ileus" are listed only those cases which apparently were not dependent upon the element of peritoneal infection.

TABLE IV
GENITOURINARY COMPLICATIONS

Complications	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
Pyelitis*	1	1	1	..	1	..	1	..	2	1	1	..	7	2
Hematuria & albuminuria transient	..	..	..	..	1	..	1	..	..	..	..	..	2	
Uremia	..	..	..	..	..	..	..	..	..	..	..	1	..	1
Acidosis	..	..	..	..	..	..	..	..	..	..	2	..	2	
Cystitis & urethritis	1	..	..	..	..	..	1	..	..	..	..	..	2	
Orchitis	..	..	..	..	..	..	1	..	..	..	..	..	1	
Totals	2	1	1	..	2	..	4	..	2	1	3	1	14	3

* In several of the cases under "Pyelitis" there was a pre-existing infection which was aggravated by the operation.

TABLE V
WOUND COMPLICATIONS

Complications	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
Infection	11	5	6	2	4	3	34	11	..	2	..	..	55	23
Serum, sterile	5	1	4	..	4	1	8	..	..	..	..	..	21	2
Hematoma	4	..	2	..	1	..	1	..	..	..	..	..	8	
Break down	1	1	1	..	1	..	3	3	2	3	6	..	14	7
Hemorrhage—on moving drains	..	..	..	..	..	..	..	..	2	..	..	..	2	
Infected silk sutures removed	..	..	..	..	..	..	..	2	..	..	..	..	...	2
Totals	21	7	13	2	10	4	46	16	4	5	6	..	100	34

* Under "Wound Infection" are included all cases which showed even superficial stitch infections, many of them of little or no consequence.

TABLE VI

MISCELLANEOUS COMPLICATIONS

Complications	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
Parotitis	1	..	..	..	..	..	..	..	..	..	..	..	1	
Hot water bottle burn	1	..	..	..	..	..	..	..	..	..	..	..	1	
Anesthesia, thigh, rt	1	..	..	..	..	..	..	..	..	..	..	..	1	
Swallowed false teeth	..	..	..	..	..	..	..	..	..	..	1	..	1	
Purulent conjunctivitis	..	..	..	..	..	1	..	..	..	..	..	..	..	1
Insanity, postoperative*	..	..	1	1	..	..	..	..	1	..	..	3	2	4
Erysipelas	..	..	..	..	..	..	..	..	..	..	..	1	..	1
Unexplained fever	..	..	..	..	..	..	1	..	..	..	..	..	1	
Total	3	..	1	1	..	1	1	..	1	..	1	4	7	6

* Several of the "Postoperative Insanity" cases were in the early groups, and were probably dependent upon a mineral salt and fluid deficiency, not then recognized.

TABLE VII

SUMMARY: COMPLICATIONS PROBABLY RELATED TO OPERATION*

Complications	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
Circulatory	4	2	3	..	1	1	3	3	6	3	2	3	19	12
Pulmonary	14	2	4	3	7	1	16	9	15	10	11	8	67	33
Abdominal	1	..	..	..	..	1	6	8	21	17	16	14	44	40
Genitourinary	2	1	1	..	2	..	4	..	2	1	3	1	14	3
Wound	21	7	13	2	10	4	46	16	4	5	6	..	100	34
Miscellaneous	3	..	1	1	..	1	1	..	1	..	1	4	7	6
Totals	45	12	22	6	20	8	76	36	49	36	39	30	251	128

* A composite of the six preceding tables.

TABLE VIII

GENERAL DISEASES—UNRELATED*

Complications	Chronic		Recurrent		Subacute		Acute		Abscess		Peritonitis		Totals	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
Neisser	..	1	..	..	1	1	1	..	1	..	..	..	3	2
Tertiary syphilis	1	..	..	1	..	..	..	..	1	..	..	..	2	1
Tuberculosis	..	..	1	..	2	..	..	2	1	..	..	..	4	2
Measles	1	..	..	..	1	..	..	..	..	..	..	..	2	
Malaria	1	..	..	..	..	..	1	..	..	..	..	..	2	
Typhoid	1	..	..	..	..	..	1	..	..	..	..	..	2	
Scarlet fever	..	..	..	..	..	..	..	..	1	..	..	..	1	
Febricula	..	..	1	..	..	..	..	..	..	..	..	..	1	
Whooping cough	..	..	..	..	..	..	1	..	..	..	..	..	1	
Arthritis	..	..	..	..	..	..	3	..	..	..	..	..	3	
Vincent's angina	..	..	..	..	..	..	1	..	..	..	..	..	1	
Totals	4	1	2	1	4	1	8	2	4	..	..	..	22	5

* In most instances these conditions were present before, and seem in no way dependent upon the operation.

TABLE IX

ABDOMINAL COMPLICATIONS—UNRELATED*

Complications	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
Pregnancy	5	1	1	..	3	..	2	1	..	..	1	1	12	3
Pelvic inflammatory	..	..	..	..	3	..	2	..	..	..	..	..	5	
Fibroid uterus—large	..	..	..	..	..	..	..	..	1	..	..	..	1	
Kidney colic	2	..	..	..	..	..	..	..	..	..	..	..	2	
Cholecystitis, acute	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Mastitis, lactative	..	..	..	..	..	..	1	..	..	..	..	..	1	
Strangulated inguinal hernia	..	..	..	..	..	..	..	..	..	..	..	1	..	1
Omental hernia	..	..	..	..	..	..	..	..	1	..	..	..	1	
Meckel's diverticulum	..	..	1	..	..	..	2	..	1	..	2	1	6	1
Teniasis	..	..	..	..	..	..	1	..	..	..	..	..	1	
Ascariasis	..	..	1	..	..	..	..	..	..	..	..	..	1	
Totals	7	1	3	..	6	..	8	1	3	1	3	3	30	6

* Of particular interest are the cases of "Pregnancy," in none of which was the operation followed by miscarriage. The one case of acute cholecystitis occurred in the fourth week following drainage of an appendiceal abscess, and required a cholecystectomy.

TABLE X

MISCELLANEOUS COMPLICATIONS, UNRELATED*

Complications	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
Neurasthenia	10	..	1	..	..	..	1	..	..	..	..	..	12	
Psychoneurosis	3	1	3	..	..	..	..	..	..	..	..	..	6	1
Insanity	..	..	..	..	..	..	1	..	..	..	..	..	1	
Drug addiction	..	..	..	1	..	..	..	..	..	..	..	1	..	2
Hyperthyroidism	..	..	..	..	..	1	..	..	..	..	..	1	..	2
Hypothyroidism	..	..	..	..	1	1	..	..	..	..	..	..	1	1
Otitis media	..	..	..	..	..	..	1	..	..	..	..	..	1	
Cervical adenitis	..	..	..	..	..	1	..	..	..	1	..	1	..	3
Other surgical treatments	5	4	3	..	1	1	1	..	..	..	..	4	10	9
Other medical treatments	1	..	..	..	..	1	..	..	..	..	..	..	1	1
Totals	19	5	7	1	2	5	4	..	..	1	..	7	32	19

* One of the cases of hyperthyroidism was dependent upon an exophthalmic goiter which flared up acutely during convalescence from a peritonitis, and in which a partial thyroidectomy was done before discharge from the hospital.

TABLE XI

SUMMARY: COMPLICATIONS APPARENTLY UNRELATED TO OPERATION*

Complications	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
General diseases	4	1	2	1	4	1	8	2	4	..	..	..	22	5
Abdominal	7	1	3	..	6	..	8	1	3	1	3	3	30	6
Miscellaneous	19	5	7	1	2	5	4	..	..	1	..	7	32	19
Totals	30	7	12	2	12	6	20	3	7	2	3	10	84	30

* A composite of the three preceding tables.

TABLE XII

PRIMARY AND CONTRIBUTORY CAUSES OF DEATH: PULMONARY

Cause	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary
Bronchopneumonia	..	1	..	1	..	..	2	..	2	2	3	3	7	7
Lobar pneumonia	..	..	..	..	..	..	1	1	..	..	..	..	1	1
Pulmonary embolism	..	..	..	..	..	..	2	1	1	..	1	..	4	1
Pleurisy	..	..	..	..	..	..	..	1	..	..	..	..	..	1
Empyema	..	..	..	..	..	..	..	..	..	..	..	2	..	2
Tuberculosis	..	..	..	..	..	..	..	..	1	..	1	..	2	
Influenza (before op.)	..	..	..	..	..	..	..	2	..	..	..	1	..	3
Bronchitis (before op.)	..	..	..	..	..	..	..	..	..	..	..	1	..	1
Totals	..	1	..	1	..	..	5	5	4	2	5	7	14	16

TABLE XIII

PRIMARY AND CONTRIBUTORY CAUSES OF DEATH: INTESTINAL

Cause	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary
Peritonitis	..	..	..	..	..	..	6	..	10	..	35	..	51	
Paralytic ileus	1	..	1	..	..	..	2	..	..	..	..	..	4	
Obstruction	..	..	..	..	..	..	..	3	2	4	5	4	7	11
Mesenteric thrombosis	..	..	..	..	..	..	1	..	..	..	..	..	1	
Fecal fistula	..	..	..	1	..	..	..	5	..	4	..	11	..	21
Gangrene, cecum	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Secondary abscess, abdominal	..	..	..	..	..	..	..	..	..	1	..	1	..	2
Strangulated hernia (before operation)	..	..	..	..	..	..	..	..	..	1	..	1	..	2
Starvation, high enterostomy	..	..	..	..	..	..	..	..	1	..	..	..	1	
Hematemesis	..	..	..	..	..	..	..	..	..	..	..	1	..	1
Totals	1	..	1	1	..	..	9	8	13	11	40	18	64	38

TABLE XIV

PRIMARY AND CONTRIBUTORY CAUSES OF DEATH: CIRCULATORY

Cause	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary
Myocarditis	..	..	..	..	..	..	..	2	..	1	1	1	1	4
Acute dilatation of heart	..	..	..	..	..	..	..	2	1	..	1	..	2	2
Septicemia	..	..	..	..	..	..	1	..	..	..	2	..	3	
Femoral phlebitis	..	..	..	..	..	..	..	1	..	..	..	..	..	1
Hypertension	..	..	..	..	..	..	..	1	..	..	..	..	..	1
Totals	..	..	..	..	..	..	1	6	1	1	4	1	6	8

TABLE XV

PRIMARY AND CONTRIBUTORY CAUSES OF DEATH: KIDNEYS, LIVER, AND PANCREAS

Cause	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary
Subdiaphragmatic abscess	..	..	..	..	..	..	..	..	..	..	..	2	..	2
Liver abscess	..	..	..	..	..	..	..	..	..	1	1	1	1	2
Diabetes	..	..	..	..	..	..	..	..	1	..	..	1	1	1
Carcinoma (head of pancreas)	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Uremia	..	..	..	..	..	..	..	..	1	..	1	2	2	2
Acidosis	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Totals	..	..	..	..	..	..	..	..	2	3	2	6	4	9

TABLE XVI

PRIMARY AND CONTRIBUTORY CAUSES OF DEATH: MISCELLANEOUS

Cause	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary
Infection, wound	..	..	..	..	..	..	..	2	..	..	..	..	..	2
Typhoid fever	..	..	..	..	..	..	..	..	1	..	..	..	1	
Scarlet fever	..	..	..	..	..	..	..	..	..	..	1	..	1	
Decubitus, sacrum	..	..	..	..	..	..	..	1	..	..	..	..	..	1
Mental case	..	..	..	..	..	..	..	1	..	..	..	1	..	2
Streptococcus throat (before operation)	..	..	..	..	..	..	..	1	..	..	..	..	..	1
No adequate explanation at autopsy	..	..	..	..	..	..	1	..	..	..	..	..	1	
Totals	..	..	..	..	..	..	1	5	1	..	1	1	3	6

TABLE XVII

SUMMARY: PRIMARY AND CONTRIBUTORY CAUSES OF DEATH*

Cause	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*		*Totals*	
	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary	1 ary	2 ary
Pulmonary	..	1	..	1	..	..	5	5	4	2	5	7	14	16
Intestinal	1	..	1	1	..	..	9	8	13	11	40	18	64	38
Circulatory	..	..	..	..	..	..	1	6	1	1	4	1	6	8
Kidneys, liver, and pancreas	..	..	..	..	..	..	..	..	2	3	2	6	4	9
Miscellaneous	..	..	..	..	..	..	1	5	1	..	1	1	3	6
Totals	1	1	1	2	..	..	16	24	21	17	52	33	91	77

* A composite of the five preceding tables. Probably about eleven of these deaths bore little if any relation to the operation or the disease for which it was performed.

NOTE: The following six charts showing the age distribution, bring out almost uniformly the greater incidence of the disease in the second and third decades of life, but the greater mortality and complication rates in the first decade, and after the fifth decade. This is particularly marked in the "Peritonitis" group.

TABLE XVIII

CHRONIC CASES

Age Distribution by Decades, Showing Number of Cases, Complications, and Deaths

Sex			0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	Age unknown	Totals
Female	Total	.....	9	122	173	72	37	29	5	..	..	3	450
	Complications	No.....	..	8	17	10	2	4	1	..	..	1	43
		Per cent.....	..	6.5	9.9	13.8	5.4	13.7	20.0	..	..	33.3	9.5
	Deaths	No.....											
		Per cent.....											
Male	Total.....	.....	2	50	129	116	55	20	4	..	..	1	377
	Complications	No.....	..	1	13	17	5	4	....	..	..	....	40
		Per cent.....	..	2.0	10.0	14.6	9.0	20.0	....	..	..	....	10.6
	Deaths.....	No.....	..	.....	.....	.....	....	1	....	..	..	....	1
		Per cent.....	..	.....	.....	.....	....	5.0	....	..	..	....	0.2

TABLE XIX

CHRONIC RECURRENT CASES

Age Distribution by Decades, Showing Number of Cases, Complications and Deaths

Sex			0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	Age unknown	Totals
Female	Total	.....	11	159	149	75	32	11	..	..	..	3	440
	Complications	No.....	2	1	6	5	1	1	..	..	..	..	16
		Per cent.....	18.1	0.6	4.0	6.6	3.1	9.0	..	..	..	..	3.6
	Deaths	No.....											
		Per cent.....											
Male	Total	.....	15	74	88	60	44	7	1	2	..	..	291
	Complications	No.....	1	4	6	6	2	3	..	..	..	..	22
		Per cent.....	6.6	5.4	6.8	10.0	4.5	42.8	..	..	..	..	7.5
	Deaths	No.....	....	.....	.....	....	1	....	..	..	..	..	1
		Per cent.....	....	.....	.....	....	2.2	....	..	..	..	..	0.3

TABLE XX

SUBACUTE CASES

Age Distribution by Decades, Showing Number of Cases, Complications, and Deaths

Sex			0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	Age unknown	Totals
Female	Total	.....	10	153	97	29	14	4	..	..	..	1	308
	Complications	No.....	1	14	10	2	....	..	..	..	..	..	27
		Per cent.....	10.0	9.1	10.3	6.8	....	..	..	..	..	..	8.7
	Deaths	No.....											
		Per cent.....											
Male	Total	.....	10	66	87	47	19	6	5	..	..	..	240
	Complications	No.....	2	3	4	6	1	..	..	..	..	..	16
		Per cent.....	20.0	4.5	4.5	12.7	5.2	..	..	..	..	..	6.6
	Deaths	No.....											
		Per cent.....											

TABLE XXI

ACUTE UNRUPTURED CASES

Age Distribution by Decades, Showing Number of Cases, Complications, and Deaths

Sex			0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	Age unknown	Totals
Female	Total	.....	42	156	141	69	27	20	5	1	..	2	463
	Complications	No.....	5	10	15	8	4	6	1	..	..	1	50
		Per cent.....	11.9	6.1	10.6	11.5	14.8	30.0	20.0	..	..	50.0	10.7
	Deaths	No.....	1	1	.....	.....	....	....	....	1	..	....	3
		Per cent.....	2.3	0.6	.....	.....	....	....	....	..	..	....	0.6
Male	Total	.....	73	201	171	110	64	32	13	1	..	1	666
	Complications	No.....	2	20	21	18	6	7	1	..	..	....	75
		Per cent.....	2.7	9.9	12.2	16.3	9.3	21.8	7.6	..	..	..	11.2
	Deaths	No.....	1	1	1	2	2	2	4	..	..	..	13
		Per cent.....	1.3	0.4	0.5	1.8	3.1	6.2	30.7	..	..	..	1.9

TABLE XXII

RUPTURED CASES, WITH ABSCESS

Age Distribution by Decades, Showing Number of Cases, Complications, and Deaths

Sex			0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	Age unknown	Totals
Female	Total	.....	24	40	27	22	20	11	5	4	..	..	153
	Complications	No.....	5	4	3	3	4	1	....	1	..	..	21
		Per cent.....	20.8	10.0	11.1	13.6	20.0	9.0	....	25.0	..	..	13.7
	Deaths	No.....	1	....	....	....	2	1	1	....	..	..	5
		Per cent.....	4.5	....	....	....	10.0	9.0	20.0	....	..	..	3.2
Male	Total	.....	25	86	53	54	24	27	13	3	..	..	285
	Complications	No.....	3	12	11	13	3	7	4	....	..	..	53
		Per cent.....	12.0	13.9	20.7	24.0	12.5	25.9	30.7	....	..	..	18.5
	Deaths	No.....	....	2	3	2	1	4	1	2	..	..	15
		Per cent.....	....	2.3	5.6	3.7	4.1	14.8	7.6	66.6	..	..	5.2

TABLE XXIII

RUPTURED CASES, WITH PERITONITIS

Age Distribution by Decades, Showing Number of Cases, Complications, and Deaths

Sex			0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	Age unknown	Totals
Female	Total	.....	12	13	13	11	13	12	3	3	.....	..	80
	Complications	No.....	3	3	5	3	4	1	1	1	.....	..	21
		Per cent.....	25.0	23.0	38.4	27.2	30.7	8.3	33.3	33.3	.....	..	26.2
	Deaths	No.....	5	1	....	4	1	4	1	.....	.....	..	16
		Per cent.....	41.6	7.6	....	36.3	7.6	33.3	33.3	.....	.....	..	20.0
Male	Total	.....	17	48	27	26	19	13	6	3	1	..	160
	Complications	No.....	2	13	7	6	2	6	....	.....	.....	..	36
		Per cent.....	11.7	27.0	25.9	23.0	10.5	46.1	....	.....	.....	..	22.5
	Deaths	No.....	4	5	6	4	7	4	3	3	1	..	37
		Per cent.....	23.5	10.4	22.2	15.3	36.8	30.7	50.0	100.0	100.0	..	23.1

TABLE XXIV

AVERAGE DURATION OF HOSPITALIZATION IN DAYS*

Group	*Chronic*		*Recurrent*		*Subacute*		*Acute*		*Abscess*		*Peritonitis*	
Sex	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Without complications	14.7	13.5	12.6	11.5	11.8	11.6	12.8	12.2	27.4	26.2	29.0	27.3
With complications	26.0	28.7	24.0	21.8	22.7	19.2	23.9	21.2	45.3	39.9	50.7	38.3

* The hospitalization in cases with complications averages approximately twice that in those without. The female, in every case, is slightly more than the male.

TABLE XXV

NUMBER AND PERCENTAGES OF DEATHS AND COMPLICATIONS

Group	Total Cases	Deaths	Percentage	Revised Total*	Complications	Percentage
Chronic	827	1	0.12	826	83	10.05
Recurrent	731	1	0.14	730	38	5.21
Subacute	548	0	0.00	548	43	7.98
Acute	1129	16	1.42	1113	125	11.23
Abscess	438	21	4.57	417	74	17.75
Peritonitis	240	52	22.08	188	57	30.32

* The "revised total" from which the percentage of complications is figured, is obtained by subtracting the total number of deaths, in each group, from the original total number of cases in that same group.

DISCUSSION

DR. RUDOLPH MATAS, New Orleans, La.: Dr. Finney's contribution is of great interest and value at this moment when the attention of the profession is everywhere centered on the postoperative complications. The classification and statistics of these complications are often so diversified and contradictory that they are the despair of the student of the subject. Dr. Finney's study is unusually thorough and comprehensive and he has apparently extracted out of his tables and figures all the statistical information that they can possibly yield. In the matter of the postoperative pulmonary embolisms, in which I am especially interested, his reports show that these have occurred 12 times in about 4,000 operations. I would like to know whether these were of the acute, sudden massive fulminating type causing immediate fatal obstruction of the pulmonary artery or the partial, smaller and multiple emboli which permit of survival as infarctions and are often classed as emboli pneumonias. Again, in connection with the appendix, were the embolisms the sequel of septic or clean cases?

I am prompted to these questions because there appears to be a very notable difference in the regional type and prevalence of postoperative embolism in the hospitals of this country, and a still greater difference in the American as compared with the European, and especially the German experience which shows a far greater excess of the fatal pulmonary embolic complications over our own.

DR. GEORGE A. HENDON, Louisville, Ky.: I wish to file a brief in behalf of enterostomy. Of course, I know its frailties and infirmities and I know it is not so well thought of, but I think a great deal of the unpopularity of enterostomy comes from the manner and the time of its performance. I think it speaks volumes for the surgical skill of any man who can do a Witzel enterostomy and make it serve a useful purpose. I know enterostomies do not accomplish everything we want them to but they give us an opportunity to do quite a number of things we would like to do. If you are going to criticize an enterostomy I would ask you, why put a handle on a jug? It does not make it hold any more, or why put a tongue in a wagon?—it does not make it talk, but thereby the utility of these two important implements is vastly increased.

MALARIA AND SURGICAL DISEASES

ROBERT L. RHODES, M.D., F.A.C.S.

AUGUSTA, GA.

THIS rather indefinite title was selected to permit for discussion a broader range of clinical observations. A more comprehensive title would be "Malaria as a Simulator of Surgical Diseases."

Surgeons have taken the attitude that malaria is essentially the problem of the internists and public health men and yet it very much concerns us in that frequently we confront it in diagnosis or as a complication. We meet it because the internist or family physician, often in the country with poorer facilities for accurate diagnosis, has exhausted his means of diagnosis before bringing the case to the hospital and us for help and, therefore, we must be keenly alert to avoid unnecessary operations. Where one is connected with a clinic or group, such cases may be weeded out before they reach the surgeon but those of us who are working individually or independently of a group, must make our own diagnosis, with or without consultation.

Economic conditions of the past several years have brought about many changes, some for the better, others for the worse. Among the latter must be classed retrenchments in state, county and city governments affecting Public Health Departments, curtailing their efficiency by decreased appropriations or eliminating the work altogether, as a consequence of which, partially at least, there has been a decided increase in some of our communicable diseases. Further, lack of funds has deterred many from calling the doctor early; indeed, has made it difficult to procure medicine, with or without the advice of the doctor. Malaria has shown a decided increase in some sections, for which the afore-mentioned facts are largely responsible, and the death rate and morbidity from it have mounted con-

siderably. Severer cases have been seen; hemorrhagic malaria and comatose malaria have again become clinical entities.

Thus, one night a doctor was called to a hovel to see a woman who had been found lying upon the floor in an unconscious state by her family. The only history he could obtain was that she had been "ailing for a week or ten days." He promptly sent her to the hospital. She arrived about 7 P.M., unconscious, temperature 104°F., pulse 140, a contused area over the parietal region about the size of a hen's egg, blood pressure 100/50; otherwise the physical examination was negative except for a spleen just large enough to be definitely palpated. The urine examination was negative and the blood chemistry findings added no information of consequence. The blood showed a leucocyte count of 5000, marked anemia, red cells 1,500,000, hemoglobin 27 per cent and differential essentially normal. Repeated blood smears, including the thick drop method (all told 27 smears), were examined with negative results by several workers during the next three hours until one of the men noticed a smear upon which he had placed stain about an hour earlier, washed and looked at it and found an overwhelming infection of aestivo-autumnal malaria. In spite of strenuous treatment, including quinine intravenously, she died before morning.

Thus we have comatose malaria presenting the problem of differential diagnosis from brain injury and an illustration of how very difficult it may be to demonstrate malarial parasites in the blood.

Frequently we meet the latent malaria stirred into activity by operations, or more correctly, by the anesthetics. It is no respecter of persons or residence because people are motoring extensively over the improved highways and frequently through sections in which malaria is prevalent, and the bite of one infected mosquito may be sufficient to transmit the infection to the individual where it may become promptly active or lie dormant for quite a time. In these latter the malaria may be stirred into activity by the influence of a general anesthetic. This also is true with the chronic malarial patient whether operated on at home or abroad and in spite of the fact that careful preoperative studies may have been made. Indeed, it is a most difficult problem to demonstrate the parasites in many chronic malarial cases. Those of us in the South are more or less familiar with this but perhaps phy-

sicians in other parts of the country are not. I would suggest that in unexplained febrile reactions in patients from malarial regions, repeated examinations of the blood may be required to demonstrate the parasites and in a few, even the therapeutic test to clear up the diagnosis. One of our late Fellows, Dr. Wm. H. Doughty, was prone to teach or suggest the giving of quinine in such cases. When asked for the reason, with a twinkle in his eye, he would say: "I do not know but it does the work." It must be recalled that his most active days were before blood smears were as routine as today and yet his conservatism was manifested by a decided hesitancy in making a definite diagnosis of malaria without the actual proof.

One might almost paraphrase Sir William Osler's remarks or teachings about syphilis to the effect that if you know syphilis, you know medicine. Malaria may be not quite so great a simulator or so damaging as syphilis but it is certainly a disturbing, if not a causative factor, in many other diseases. Even that most commonplace malady, acute appendicitis, may be very closely simulated by it. During the past eighteen months we have seen 32 cases with the classical symptoms of acute appendicitis: generalized abdominal pains, with nausea and vomiting, pains later localizing in the right lower quadrant with definite tenderness but very little rigidity and a higher fever than would be expected in the case. These two latter features were the fingers of suspicion as to the correct diagnosis. The white blood counts have varied from 7000 to 13,000 but the smears have shown the diagnosis by revealing the malarial parasites, which were nearly all of the aestivo-autumnal type. You will recall that this type frequently produces no chill or only slight chilly sensations preceding the high fever.

One man, whose secretary we had operated upon a few weeks previously for acute appendicitis, was so sure of his diagnosis, that he packed his grip and started to the hospital. On the way, he stopped by his office to sign some letters, from where he notified me of his intention and I suggested that he come up to my office, in the same building, for examination. Nothing was lacking in his history. He was quite tender and somewhat

rigid over McBurney's point but his abdomen was as hot as an oven, temperature 105.6°F. The blood smear demonstrated malaria and quinine cured him without an operation.

Often we are confused, especially in less typical cases and in those whose blood smears do not at once clarify the diagnosis and in the cases of so-called chronic appendicitis. Many of these cases require most careful study and repeated examinations lest a needless operation be done.

In rapid succession 3 patients were sent to me for curettage because of sudden severe uterine hemorrhage. There was no definite history to suggest incomplete abortion, or of past menstrual disorders; pelvic examinations failed to reveal any definite pathology but each one had very high fever. Since the rule is to avoid the curette in febrile cases, we did not curette. In two, the diagnosis of malaria was determined fairly promptly but in one, about thirty-six hours was required and not until after an intravenous dose of cacodylate of soda. In the meantime, the family was making it unpleasant for me because they had been told that a curettage was urgently needed and it had not been done. Of course "all's well that ends well" and happily, quinine ended these well. In hemorrhagic malaria hemorrhage may occur from the urinary tract, gastrointestinal tract or any other part of the body. Again we have seen cases of uterine hemorrhage over a period of several weeks, more or less continuously, in patients in whom the first thought would be cancer. Pelvic examination could promptly rule out cancer of the cervix but adenocarcinoma of the fundus is not so readily excluded. However it seemed that examination could rule out any apparent trouble and fortunately a diagnostic curettage was avoided by the finding of malaria and prompt response to quinine.

We have seen several cases of polyarthritis, both acute and chronic, apparently caused by malarial infection. No other focus of infection could be found. Malaria was demonstrated in the blood, treatment instituted, and the arthritis promptly cleared up.

The association of malaria and biliary disease is more interesting even though more tantalizing. Malaria is one of the most common causes of that symptom complex called "biliousness." The differential diagnosis between it and definite biliary disease is a difficult problem; in some cases it can not be done until after prolonged and careful study. Perhaps "biliousness" and its underlying cause may be but one of the forerunners of definite biliary disease, the latter being a later stage in the progress of the former; certainly there is no proof to the contrary. I do not mean to imply that there are not many other factors in the development of biliary disease but I do wish to emphasize the foregoing as one of the contributing factors in many cases.

This was impressed rather forcibly upon me in 1930 when 4 cases were seen in rather close order, in people who had recently moved to our city. They had been cholecystectomized shortly before, because of definite gall-bladder disease, and with definite pathology found to warrant removal of the gall bladder. And yet when they consulted us, they still gave a very definite history of biliary trouble, even complaining that they continued to suffer just as they had before the operation, except two patients, who had had stones in the gall bladder, stated they had not had an attack of actual colic. After considerable effort and study, malaria was found, appropriate treatment instituted and their symptoms cleared up completely. About this time one of our own cases showed a similar development. These prompted us to check up further on our gall-bladder patients. Of those having any complaints suggestive of biliary trouble or biliousness, some were personally seen, some through the family physician and others only by letter. To our surprise a number had complaints more or less similar to those existing prior to operation and of these some were found to have a malarial infection and were relieved or greatly improved by treatment. Since statistics are so notoriously inaccurate, I have preferred to use the foregoing indefinite statements rather than attempt a statistical report.

During the last two years we have studied our gall-bladder cases very much more closely, especially with respect to an associated malarial infection, and have had most of these patients return monthly for inquiry and examination until we have been satisfied they were free from former symptoms and complaints. This study has shown that about 75 per cent had an associated malaria. In a trifle less than 50 per cent, the infection was found before operation and vigorously treated until we felt that it should be eliminated. About 10 per cent of these patients experienced complete relief from all symptoms and signs, which had been interpreted as indicative of gall-bladder disease; even the sluggish or delayed emptying of the gall bladder as shown by cholecystogram had cleared up, indicating, therefore, an erroneous diagnosis. The remainder of this 50 per cent, who showed more definite evidence of cholecystitis or of stones, were then operated on and the gall bladders removed. Several of these patients, along with the remainder in the 75 per cent, failed to obtain the expected relief by the operation but continued to suffer from "biliousness" (since the gall bladders were out) and in them, malaria was subsequently found, possibly stirred up by the anesthetic though not one was evident during the stay of the patient in the hospital after the operation. Indeed two months after the operation was the earliest we found it in any case. That their former symptoms persisted to a greater or lesser degree after operation and that they cleared up promptly after the finding of malaria and the institution of active treatment, made us feel that the infection was present before and at the time of operation (we simply failed to find it) rather than that they may have contracted it after going home from the hospital. This leaves us then with only about 25 per cent of patients who were at once and completely freed of symptoms after cholecystectomy. We have frequently been questioned by family physicians as to our end-results in gall-bladder cases, they stating that their observations in such patients who had had operations were more or less unsatisfactory. At least, a part

of the answer may be found here. We feel that these figures, even though they indicate our findings, do not truly represent the facts in biliary surgery but rather a coincidence that malaria should play a factor in such a large proportion and due largely to the increase of malaria during the last several years. However, we feel very emphatically that patients with gall-bladder disease require just as careful watching and guidance postoperatively as do those with disease of the thyroid or with duodenal ulcers; that the operation merely is the turning point in the patients' career, after which he is just beginning to recover health, and that earnest attention should be given to the elimination of all factors entering into the causation of the gall-bladder disease whether it be malaria, "biliousness," intestinal stasis, focal infection or what not, and that they should not be dismissed from observation until this is accomplished.

In conclusion, I would remind you of one other similarity of malaria and syphilis, that of wound healing. Long have we been apprehensive of this in syphilitics, when forced to operate in the face of a four plus Wassermann reaction. Heavily infected malarial patients, especially of the old chronic type, may experience marked delay in wound healing and hernias occur in a much larger percentage than from similar operations in patients not so afflicted.

I cannot overlook this opportunity in a discussion of malaria to digress sufficiently to pay tribute to the sagacity of my grandfather, Dr. L. D. Matthews, of Matthews, Georgia (1829–1898), and to put on record his observation that quinine was most effective when administered just before and immediately after the chill in malaria. In his practice he did this as early as 1860. At that time the practice was to give quinine well before in an effort to prevent the chill, and there prevailed a very strong sentiment against giving it for several hours before and until some hours after the chill, for what reason I have never been able to learn. My grandfather was severely criticized by his fellow practitioners, but fortunately for him

his patients made more prompt recoveries than those treated by the orthodox method, and his "heretic practice" (as it was termed) was adopted by others. Twenty-five years later it was demonstrated that the chill corresponds to the segmentation of the mother parasite into the daughter parasites, and thus the explanation of his results; it is easier to kill an infant than an adult.

DISCUSSION

Dr. Barney Brooks, Nashville, Tenn. Because of my experience during the past six years, I am convinced that the responsibility for the recognition of malaria frequently rests upon surgeons. We have come to recognize two groups of cases of malaria in surgical wards.

One group is made up of patients operated upon for conditions which could not possibly be related to malaria, as, for example, acute appendicitis or hernia, and who develop after operation the characteristic symptoms of malaria. These patients may have been free of any symptoms of malaria for long periods previous to operation.

The other group is made up of patients who have been admitted to the hospital for symptoms attributable to acute intra-abdominal disease. The most frequent diagnosis at the time of admission is acute cholecystitis. Examination shows tenderness in the upper right abdominal quadrant, high fever and marked leucopenia. Examination of the blood shows the presence of malarial parasites, and the administration of quinine promptly relieves the patient's symptoms.

Malaria is apparently becoming more frequent, and a patient who complains of comparatively sudden onset of pain in the upper right abdomen, and who has a relatively high temperature and low leucocyte count, should be suspected of having malaria.

Dr. R. L. Rhodes (*Closing*): These observations were entirely upon private patients and if encountered among such, how much more often may similar findings occur among those less fortunate ones who make up our ward patients? It seems to me that these factors of differential diagnosis have not been sufficiently emphasized.

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EDITORIAL

THE TRADITION OF THE SOUTHERN SURGICAL ASSOCIATION

THE Southern Surgical Association was founded nearly half a century ago "to further the study and practice of Surgery in its various departments, especially among the profession of the Southern States." It was founded just after Pasteur, the chemist, and Lister, the surgeon, had formulated and put into practice those principles which created the

modern science of bacteriology and which transformed surgery from a limited exercise of technical dexterity to an art almost limitless in its applications and its achievements. In the era of transition in which this society was conceived and established, its founders might reasonably have been excused if they had made pure science its chief aim. But they did not. They saw, more clearly, alas, than do many of us today, wherein lie the true medical values. They were among the most eminent surgeons of the country, these men who founded the Southern Surgical Association, but they were clinical surgeons before they were anything else. They were not misled by the tremendous events that were taking place around them; they were able to analyze them and to evaluate them correctly and impartially. They recognized the fundamental basis upon which surgery as a science is founded, but they realized with equal clarity that the ultimate aim of the surgical art is not the exhibition of scientific principles but the healing of the sick. Their emphasis upon the art rather than upon the science of surgery colors their communications, permeates their discussions, is implicit in their every pronouncement.

Few of the surgeons of that generation are still among us. Their places have been taken by those whom they trained to follow them, their sons in the craft, as it were, and one generation has succeeded to another. But the ideals of the Southern Surgical Association are unchanged. It is still loyal to the "faith once delivered" to it. It has preserved the traditions of its founders, and the "preservation of good tradition," as Sir Clifford Allbutt says in one of his essays, is quite as important as the enunciation of new discoveries. The membership of the society still includes the most eminent of the surgeons of America, Crile, Finney, Kelly, Matas, the Mayos and their like, its members are still chosen on the basis of their surgical achievements and their unblemished surgical records, they are still surgeons whose emphasis is ever upon the clinical aspects of their specialty. The dominant interest of the Southern Surgical Association is still the surgical art, is still

the healing of the sick. So long as this tradition endures, so long will the Association continue to stand for what it represents today, the practice of surgery at its highest and best, because, while it is founded upon scientific principles, it is dedicated to the application of those principles in the service of humanity.

URBAN MAES.

ACUTE INTESTINAL OBSTRUCTION

MONROE A. McIVER, M.D., F.A.C.S.

SIXTH INSTALLMENT

PART I: THE DISEASE

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Chapter XV

FUNCTIONAL OBSTRUCTIONS

In the preceding chapters we have been considering the intestinal obstructions of mechanical origin. We shall now take up the mechanism, etiology and clinical types of obstructions caused by functional disturbances of intestinal motility.

Mechanism of Functional Disturbances of Intestinal Motility

Functional disturbances of intestinal motility may be the result of local or intra-abdominal pathology, or may be a reflex response to general or distant bodily pathology. For example, we may have an atonic paralysis of the intestines as a result of acute peritonitis; or, on the other hand, the passage of a renal stone or certain other lesions of the kidney may cause reflex vomiting and a cessation of peristaltic movements. (Fig. 44.)

The mechanism governing the highly coördinated movements of peristalsis is complicated. It depends upon the muscle structure of the gut wall, with its local nerve supply, and is also influenced by an extrinsic nerve supply through the splanchnic and vagus nerves. Thus injury to the muscle or nerve elements in the gut wall might abolish peristalsis; or reflex impulses transmitted over the extrinsic nerves might bring about the same result. The situation is further complicated by the fact that the bowel may respond to one and the same injury at times by an atonic paralysis or inhibition of motility, and at other times by a spasmodic, tonic contraction of some segment of the intestine which effectually interferes with the passage of intestinal contents and so blocks the intestinal stream. Because of this fact it has long been the custom to describe the functional obstructions as "paralytic" and "spastic." Inhibition of intestinal movements (paralytic type) is much the

more frequent process underlying functional obstructions, and it is largely this type that has been studied experimentally.

In order to understand more clearly the effects of injuries

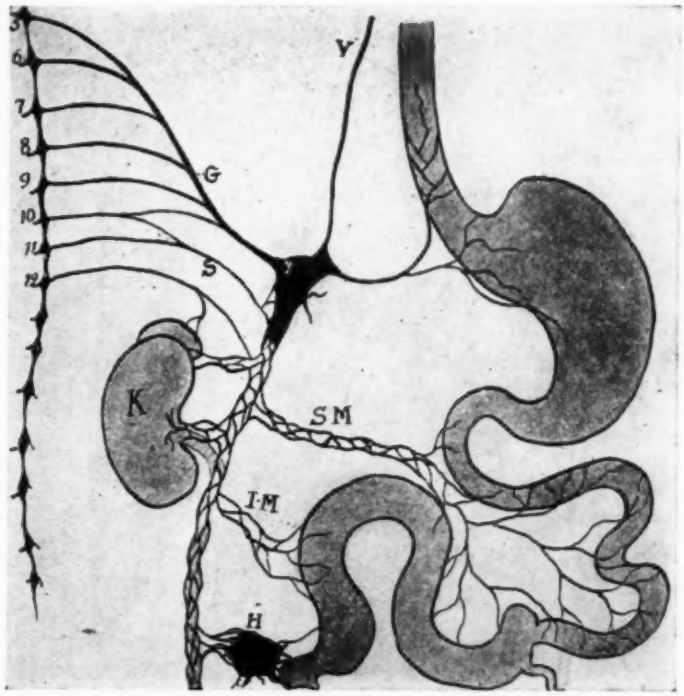

FIG. 44. Intimate connection between nerve supply of kidney and of intestines. K, kidney; V, vagus nerve to celiac ganglion; G, greater splanchnic nerve; S, smaller splanchnic nerve; SM, superior mesenteric plexus; IM, inferior mesenteric plexus; H, hypogastric plexus. Note how nerves of kidney and ureter communicate in celiac ganglion with those of stomach and intestine. (Eisendrath[1])

to various parts of the system governing intestinal movements, it is desirable to review briefly the major facts of normal peristalsis and the experimental work on intestinal movements under conditions of obstruction.

PERISTALSIS. The intestinal contents are normally propelled through the great length and numerous convolutions of the intestinal tract by a series of coördinated muscular contractions known as "the peristaltic wave." Cannon[2] has described the wave as occurring in two forms: one, a slowly advancing contraction that goes only a short distance; the other, a swift movement that sweeps for longer distances along

the canal. This latter in its most marked form may spread over the whole length of the small intestines in about one minute; it is called by Meltzer and Auer[3] the "peristaltic rush."

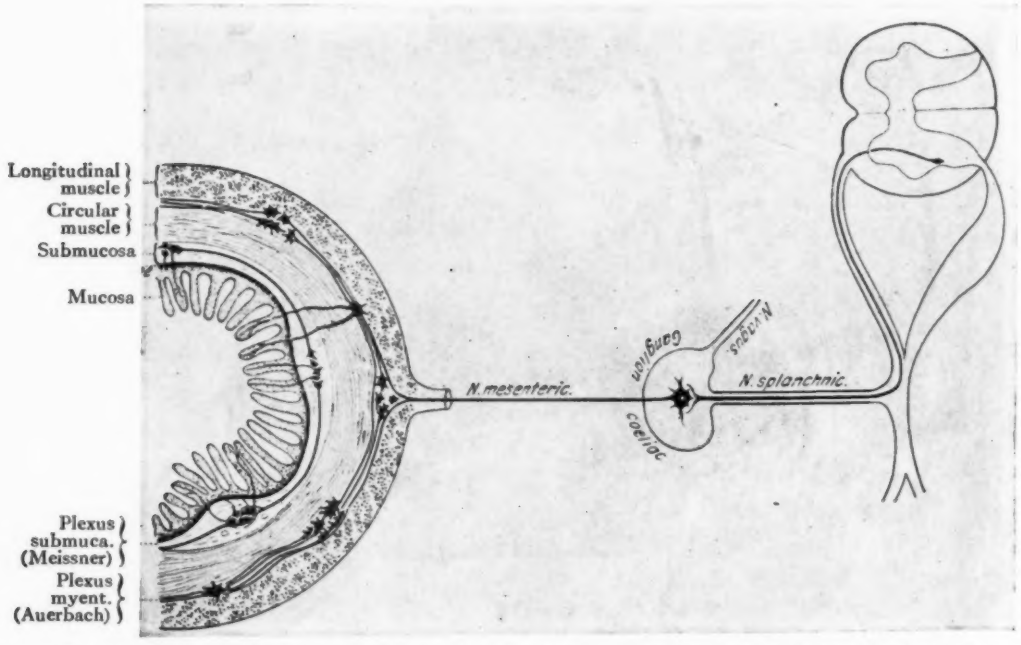

FIG. 45. Schematic representation of intrinsic nerve supply to gastrointestinal tract, showing location of submucous plexuses, etc. (Müller; see Braun and Wortmann[5])

In addition to the peristaltic waves, there are rhythmic contractions of the intestinal musculature which segment without advancing the contents; and associated with this are gently swaying movements of the loop, the so-called "pendulum movement."[4]

INTESTINAL INNERVATION. The intestines have an intrinsic and an extrinsic nerve supply (see Figs. 45 and 46).

Intrinsic Innervation. The intrinsic innervation consists of two nerve plexuses in the intestinal wall: the submucous plexus (Meissner's plexus); and the more important myenteric plexus (Auerbach's plexus), which lies between the circular and the longitudinal muscle layers and serves to conduct stimuli and to coördinate movements. Upon this plexus depends the local reflex, the "myenteric reflex" (Cannon[6]), which, according

to Bayliss and Starling,[7] governs the orderly progress of the intestinal contents, a wave of contraction being preceded by a wave of relaxation. Alvarez[8] questions the importance of the

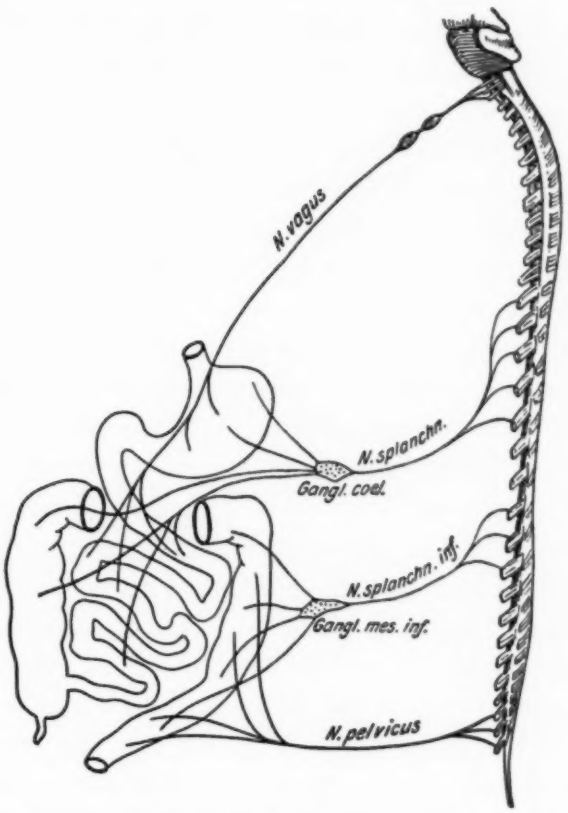

FIG. 46. Schematic representation of extrinsic nerve supply to gastrointestinal tract. (Müller; see Braun and Wortmann[5])

myenteric reflex in the propagation of the peristaltic wave. According to his view, the downward passage of a wave is due to gradients of irritability, tone and metabolism between the upper and the lower portions of the intestinal tract. Cannon[9] considers the myenteric reflex important in the propagation of peristalsis; but clearly states that it does not govern the rhythmic contractions of the small intestine, or the rhythmic peristalsis and antiperistalsis of the colon, and probably not the rhythmic waves of the stomach.

Extrinsic Innervation. Although the intrinsic innervation is complete in itself, and capable of carrying out in an orderly manner all types of peristalsis without connection with the central nervous system,[10] under normal conditions it is influenced by impluses from the central nervous system, transmitted over two opposed systems which together constitute the extrinsic innervation: the motor system, represented by the cranial (vagus) and sacral autonomic nerves, whose impulses tend to stimulate intestinal movements and increase tone; and the inhibitory system, consisting of the sympathetic fibers (splanchnics), whose impulses tend to abolish intestinal movement. The sympathetic system also carries motor fibers to the pyloric and ileocecal sphincters.

The cranial autonomic system, through the vagus, supplies fibers to the intestinal canal from the esophagus to the terminal ileum, diminishing in influence as it descends; the sacral system starts at the anal end of the canal and reaches upward along the colon with diminishing influence as it ascends. Stimulation of these nerves produces powerful contractions of the intestinal musculature. It is not known where the ganglion cells of these motor neurons to the stomach and intestines are situated; and therefore we do not know with certainty that the vagus carries preganglionic fibers to these organs. Gaskell,[11] however, thinks it probable that the motor cells are situated in Auerbach's plexus.

The sympathetic fibers arise in the thoracico-lumbar region and reach the abdomen by way of the major and minor splanchnic nerves, the preganglionic fibers ending in ganglion cells in the celiac plexus. It has not been finally settled whether there also exist ganglion cells belonging to the sympathetic system in the intestinal wall; but the evidence as presented by Gaskell[12] seems against it. Stimulation of the splanchnic nerves inhibits peristalsis and constricts the ileocecal and pyloric sphincters. The blood vessels are also constricted by stimulation of these fibers.

Neurogenic and Myogenic Theories of Intestinal Movements. Intestinal peristalsis is carried out by a neuromuscular mechanism consisting of the smooth muscle of the intestinal musculature, and the intrinsic nerve supply already described. The respective parts played by nerve and muscle in the initiation and propagation of intestinal movements is a moot point in intestinal physiology. The views on this question are embodied in two theories: the neurogenic and the myogenic. While there is no conclusive evidence on which to decide between the two theories,* it may be pointed out that the chief types of intestinal movements, that is, the rhythmic contractions and the peristaltic waves, may depend upon different mechanisms, the former simpler and more primitive movements being simply a function depending upon the well-known inherent ability of smooth muscle to contract in a rhythmic manner, while the more complicated and highly developed peristaltic wave may depend upon the nervous elements for its initiation and propagation. This is a point of some practical importance in considering the functional disturbances of motility; for diverse types of injury may affect different portions of the neuromuscular mechanism.

Experimental Work on Functional Obstructions

As already stated, the injuries causing the inhibition of intestinal motility which in its severe forms constitutes complete intestinal paralysis, may be grouped as general or distant bodily injuries, and local or intra-abdominal injuries, the former bringing about reflex disturbances of motility. The occurrence of obstructions due to these major types of injury has been recognized from the time of Henrot[15]; but the exact way in which they come about is not generally agreed upon.

* It has been difficult, for a number of reasons, to establish either of these theories conclusively, particularly because of the intimate anatomical relations between muscle and nerve: the muscle bundles are surrounded by nerve filaments, and even the smallest collection of muscle fibers shows ganglion cells. Methods tending to destroy one without the other may be inconclusive because of the surprising resistance to anemia of this type of ganglion (Cannon,[13] Gunn and Underhill[14]). An introduction to the literature will be found in the references of Cannon, Gaskell and Alvarez.

Experimental Work on the Effect of General or Distant Bodily Injuries. Cannon and Murphy[16] showed experimentally that distant, pathogenic processes were capable of inhibiting intestinal movements. They studied this phenomenon under several conditions. They noted, in the first place, that asthenic states occurring in the course of general infections tended to abolish or inhibit intestinal peristalsis. Next, they studied the effects of powerful sensory stimuli which they produced by injury to the testicles of the anesthetized cat, and found that such sensory stimulation also caused an inhibition of intestinal movements. These authors further showed that the stoppage of intestinal movements under the foregoing conditions was due to inhibitory impulses from the spinal cord, transmitted over the splanchnic nerve; for when they sectioned this nerve the inhibition was abolished. As regards the inhibition of peristalsis during asthenic states* it was a striking observation that following section of the splanchnic nerves intestinal peristalsis was observed even in moribund animals. This reflex mechanism, whereby distant lesions are able to bring about an inhibition of intestinal movements, is now generally accepted. The experimental observations of Cannon and Murphy have been recently confirmed by King.[17]

Experimental Work on the Effect of Local or Intra-abdominal Injury. There are numerous kinds of intra-abdominal injury which are capable of affecting intestinal motility, and there is no reason *a priori* to suppose that the mechanism is the same in all cases. Only two types of obstruction produced by local injury have been studied experimentally in any detail. These are, first, those following mechanical trauma to the gut by rough handling; and, second, those following bacterial peritonitis.

Injury by Mechanical Trauma to the Gut. Cannon and Murphy,[16] in the work referred to in the preceding

* It is well known clinically that patients with uremia may have marked inhibition of intestinal movements, great distention and vomiting. Instances have occurred where they have been operated upon under a mistaken diagnosis of intestinal obstruction. The exact mechanism of this type of functional inhibition of peristalsis is not known.

paragraph, also investigated experimentally the inhibition of intestinal peristalsis that follows trauma to the gut. They found that they were able to produce strong inhibition of intestinal movements by rough handling of the intestines (of the anesthetized cat) and considered that the inhibition of movements following this type of injury was probably due to direct injury to the neuromuscular mechanism of the intestinal wall. They were of the opinion that inhibitory impulses from the spinal cord did not play any rôle in this instance, for the inhibition was not removed by section of the splanchnic nerves.

This work has recently been confirmed by Olivecrona.[18] This author, however, considered that another possibility, aside from injury to the neuromuscular mechanism of the bowel or inhibitory impulses from the spinal cord, might explain the inhibition: namely, that there might be a local reflex by way of the celiac plexus. Having first confirmed the observation of Cannon and Murphy that section of the splanchnic nerves did not abolish the inhibition of intestinal movements produced by trauma, he removed the celiac plexus as thoroughly as possible; and, after allowing time for the degeneration of the nerve fibers, traumatized the intestines and found that the usual post-traumatic inhibition was almost completely absent. These experiments were few in number, and not altogether conclusive; but Olivecrona considered that they proved that trauma to the gut may produce inhibition by local reflexes through the celiac plexus, rather than as a result of injury to the neuromuscular structure of the gut wall itself.

Injury from Peritonitis. Aside from gross mechanical trauma to the intestines, peritonitis of bacterial origin may, as is well known, seriously interfere with intestinal motility. The various views as to the mechanism by which peritonitis brings about functional inhibition of intestinal movements are vague. Most writers (Wilms[19]) assume that both muscle and nerve plexuses are affected by the edema and inflammation resulting from the action of bacteria and their toxins. This was also essentially the view of Cannon and Murphy,[16] who assumed

that the mechanism was the same as in the case of mechanical trauma (namely, direct injury to the intestinal musculature and its intrinsic nerve supply) and that section of the splanchnic, therefore, should not abolish the inhibition. Arai,[20] however, found that when he produced peritonitis by intraperitoneal injection of sublethal doses of bacteria, inhibition of movement occurred; if, however, the splanchnic nerves were first cut, no inhibition followed the peritonitis. This was also true when he produced a chemical peritonitis by injection of an irritating solution (5 c.c. per kg. body weight of Lugol's solution). He concluded that in peritonitis inhibition of intestinal movements was produced by inhibitory influences from the spinal cord. Olivecrona[18] was not able to confirm Arai's observation that section of the splanchnic nerve abolished the inhibition of intestinal movements caused by peritonitis of bacterial origin. He explained the difference between his own findings and Arai's by the fact that he had produced a rapidly advancing, fatal peritonitis; and drew the conclusion that in the milder grades, paresis of intestinal movements was brought on by inhibitory influences from the spinal cord, while in the more severe forms the disturbances of intestinal motility were caused by injury to the neuromuscular mechanism in the wall, agreeing in this with Cannon and Murphy.[16] But since he found that neither mechanical trauma nor peritonitis abolished rhythmic contractions, he inclined to the belief that the chief injury is sustained by the nerve elements rather than by the muscular structure. Lennander[21] considered that the most important factor was damage to Auerbach's plexus. Supporting this view is the work of Askanazy,[22] who considered that histologically he could demonstrate degenerative changes in this plexus, consisting chiefly of edema around the nerve cells. The importance of these observations of Askanazy is, however, open to question: Marchand[23] and Orth[24] found the same histological picture in typhoid, dysentery and other inflammatory conditions, usually unaccompanied by symptoms of obstruction; and Walbaum[25]

pointed out that similar findings might be demonstrated in normal intestines as a result of post-mortem changes. Walbaum further pointed out that histological changes in the intestinal wall as a result of peritonitis could be demonstrated only late in the disease, while functional disturbances often occurred early. Hotz[26] considered that where obstruction and peritonitis were both present, the bowel was more injured by the obstruction and distention than by the external inflammation.

SUMMARY. It may be said in summary that pathological processes outside the peritoneal cavity may cause inhibition of intestinal movements. These inhibitory impulses are transmitted over the splanchnic nerves; and following section of these nerves the inhibition is abolished. Functional inhibition of motility caused by intra-abdominal injury may be the result of damage to the neuromuscular mechanism in the gut wall; or it is possible, at least in the less severe forms of peritonitis, that inhibitory impulses from the spinal cord, transmitted over the splanchnic nerves, may play a rôle (Arai[20]). Olivecrona[18] has contended that local reflexes through the celiac ganglion may also play a part. Since this author found that the inhibition of peristalsis produced by either mechanical trauma or bacterial peritonitis did not abolish rhythmic contractions, it would appear that the chief injury is sustained by nerve elements rather than by muscle; although this is not certain, and attempts to demonstrate the nature of the lesion by histological methods are not conclusive.

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[Continued on p. 832.]

*Continued from the May installment, p. 513.

Chapter XVI

FUNCTIONAL OBSTRUCTIONS (Continued)

Varieties of Functional Obstructions

Paralytic Type. In considering the clinical aspects of functional obstructions of the paralytic type, the cases fall naturally into the two groups already discussed from the experimental point of view in the preceding chapter: namely, disturbances of motility resulting from local, intra-abdominal pathology; and reflex disturbances resulting from distant lesions.

The more important disturbances among the first group are those that arise as a complication of peritonitis, those that follow operative procedures or other forms of mechanical trauma, and those occurring as a complication of mechanical obstruction. The most frequently encountered and most serious cases are those accompanying peritonitis.

Functional Obstruction from Peritonitis. Disturbances of intestinal motility may be caused by acute peritoneal infection in two ways: mechanically, by the production of adhesions; and functionally, by causing paralysis and atony of the intestinal canal as a result of injury to the neuromuscular structure of the gut, as discussed in the preceding chapter.* Frequently the obstruction is found to come about as a result of both these conditions, and there is present in the same case a mechanical and a functional element.

The following case is illustrative of the functional disturbances of motility associated with diffuse peritonitis; there was apparently no mechanical element in the obstruction:

* On the basis of the work described in the preceding chapter it must be admitted that even in cases where local damage to the gut is the outstanding factor there may at times be some reflex element in the inhibition of motility.

CASE XXVII. *Functional obstruction associated with peritonitis.*

No. 256152, M. G. H. Male, aged fifty-three, entered the Hospital with a typical history and physical findings of acute appendicitis. He appeared to be acutely ill; temperature 101°F., white blood count 26,000.

The patient was operated upon and a ruptured appendix with abscess formation was found. The abscess was partially walled off; although the notes state that there was considerable free fluid in the general peritoneal cavity.

Following the operation the patient had a stormy convalescence. Marked distention of the abdomen was present, and there was some discomfort from this source, but no colicky or cramp-like pains suggesting mechanical obstruction. Enemas, poultices and rectal tube were tried, but little gas was expelled and the distention was not relieved. The patient showed very little elevation of temperature (usually from 100° to 101°F.).

On the ninth day postoperative, the patient's general condition was said to be worse, the most outstanding symptom being the persistent distention. An enterostomy was decided upon, and an ileostomy, under novacaine anesthesia and without any exploratory operation, was carried out according to the Witsel method; a catheter was inserted into a distended loop of gut and the omentum was sutured around the point where the catheter emerged from the gut. There was no relief of distention following the operation; there was very little drainage from the catheter. The patient died the next day. At necropsy a general fibropurulent peritonitis was found.

Comment: Sepsis was undoubtedly the chief factor in this patient's death, the symptoms of obstruction being due to a generalized atonic condition of the intestinal tract and no improvement following the drainage of a distended coil. It will be noticed in the postoperative notes that following the first operation there was no evidence of colicky pains or other signs of increased peristalsis such as is usually associated with mechanical obstruction.

The foregoing case seems to be an example of pure functional obstruction. As has already been stated, it is not uncommon in connection with peritonitis to have both a mechanical and a functional element present in the same case. This is illustrated by the following history:

CASE XXVIII. *Obstruction complicating peritonitis and having both a mechanical and a functional element.*

No. 287917, M. G. H. Female, aged thirty-one. The first operation consisted in drainage of a tubo-ovarian abscess. Following the operation the patient had a somewhat stormy convalescence, with a temperature range between 102° and 103°F. There was a profuse drainage from the abdominal

wound. The culture of the pus from the wound showed a hemolytic streptococeus. Abdominal distention was persistent, but was somewhat reduced by enemas.

On the fifteenth day postoperative, the operative notes state that the abdominal distention was more marked and the patient was complaining of severe, cramp-like, colicky pains. The drainage from the wound was still profuse. It was decided that intestinal obstruction was present, and operation was advised.

Operation (under novacaine anesthesia) consisted in the insertion of a catheter into a dilated coil of small intestine. There was immediate relief of all symptoms of obstruction following the enterostomy, and the patient was eventually discharged in good condition.

Comment: In this case there was probably atony of the loops of small intestine in the region of the pelvic abscess, due to inflammation and infection. Kinking of the intestines by recent inflammatory adhesions doubtless added a mechanical element. The severe, cramp-like pains showed that there was no general atony, clearly indicating that vigorous peristalsis in the upper bowel was attempting to push the intestinal contents beyond a point of obstruction.

There was a twofold reason why at the time the enterostomy was performed it was deemed unwise to carry out any extensive exploration. In the first place, the exploration would have been likely to disseminate the peritonitis which now was localized in the region of the abscess. In the second place, it is known from experience that these obstructions coming on early after operation and caused by light adhesions combined with functional atony of certain coils do very well if the bowel above is drained, without any attempt to find the exact point of obstruction. There was no bloody fluid in the peritoneal cavity; and while this does not rule out the possibility of strangulation it makes it seem unlikely.

While undoubtedly the patient had some toxic absorption from the localized peritonitis, the outstanding feature of this case at the time of the second operation was the intestinal obstruction.

Functional Disturbance as a Complication of Mechanical Obstruction. The late stages of most cases of mechanical obstruction are complicated by functional disturbances of the motility of that portion of the bowel lying above the obstruction. It is not infrequently found that when patients are operated upon late in the disease the bowel does not regain its motility even when the mechanical difficulty has been relieved, the normal tone and peristalsis having been completely

abolished by the long-continued distention and resultant injury to the capillary circulation of the intestinal wall. Perhaps, also, the toxic contents of the obstructed bowel plays a rôle. Administration of ether to these late cases is likely to enhance this functional disturbance. The atony may not involve to an equal degree the whole intestinal tract lying above the obstruction, but may be largely confined to some particular loop immediately related to the mechanical obstruction.

Functional Disturbances after Operative Procedures. Minor degrees of functional disturbance are among the most common complications that follow abdominal operations,[1] even when no peritonitis is present; for, as shown experimentally (see preceding chapter), handling of the intestines is capable of producing inhibition of motility. This disturbance usually amounts to no more than slight distention; there are cases in the literature, however, where the symptoms have progressed to the point of real functional obstruction, exploratory operation or autopsy showing a general atonic dilatation of the intestinal canal but no mechanical obstruction. Clinically, this group is of minor importance, since practically all the true obstructions that come on early after operation have a mechanical basis or occur as a complication of peritonitis.

In connection with these functional disturbances due to local trauma, Richards, Fraser and Wallace[2] have pointed out that resections and anastomoses for gunshot wounds of the intestines are often followed by functional obstruction, the segment above the anastomosis becoming distended and paralyzed. This result may follow even though the operation take place relatively soon after the injury. Although localized peritonitis frequently plays a part in this picture, these authors consider that the functional element due to trauma to the gut is an important factor.

Reflex Disturbances from Distant Pathological Processes. Functional disturbances also occur where there is no intra-abdominal lesion, the inhibition of intestinal movements being caused by some pathological process in a distant part of the

body and the peritoneal cavity itself being unaffected. The reflex mechanism which brings this about has been discussed in the preceding chapter. Clinically these cases are rare, and therefore from a practical point of view relatively unimportant; yet they are occasionally encountered, and represent such an interesting problem in the functional pathology of the gastro-enterological tract that considerably more space in the literature is given to them than they deserve on the basis of their frequency.

Functional disturbances caused by distant lesions have been reported as occurring most frequently in connection with renal pathology (tumors, infections, operations or colic). They have also been observed following retroperitoneal hemorrhage or infection.[3] Eisendrath[4] stresses the intimate relationship between the splanchnic nerve supply to the kidneys and to the intestines. Tixier and Clavel[5] have also discussed the reflex mechanism whereby pathological processes in the kidneys or retroperitoneal tissue produce serious gastro-intestinal disturbances. (See Fig. 44.)

The following case illustrates the condition in which an infectious process of the kidney resulted in reflex inhibition of intestinal motility of such severity as to bring the patient to operation under the diagnosis of intestinal obstruction:

CASE XXIX. *Functional obstruction following infection of the kidney.*

No. 251029, M. G. H. Male, aged sixty-eight. Three days before admission the patient was taken with sudden, severe abdominal pain. There has been some localization of the pain in the right lumbar region; the pain has been of sufficient severity to require morphia. The bowels have not moved since the onset of the symptoms. There has been constant nausea and regurgitation of "watery material." There have been no urinary symptoms.

Physical examination showed the abdomen greatly distended and tympanitic. There was generalized tenderness, even to the slightest pressure.

The patient was operated upon under local anesthesia. The distention of the intestines was so great that an exploratory operation could not be carried out. The cecum was found to be distended, and a tube was inserted into this organ.

The patient died five hours after operation. At necropsy the abdominal examination was negative except for great distention of all the intestinal tract. There was pyonephrosis of the left kidney, with stones.

Functional obstruction following fractured ribs has also been reported. Adams[6] observed 2 such cases, Ralphs[7] one. The following is a brief abstract of Adams' first case:

CASE XXX. *Functional obstruction following fractured ribs.*

Male, aged sixty-six. Three days before admission the patient fell and fractured several ribs on the right side. The affected side was strapped. The bowels had been regular before the accident; afterwards they did not move even with enemas. The patient became markedly distended, and vomited profusely.

An exploratory laparotomy was carried out, but no organic obstruction was found. The patient developed severe shock and died. Autopsy was essentially negative, except for great intestinal distention.

Adams' second case recovered following an ileostomy.

Intestinal motility is influenced by the general bodily state. Marked inhibition of intestinal motility will occasionally occur in the course of acute infections, notably pneumonias, the resultant abdominal distention being at times a serious complication. Symptoms suggestive of true intestinal obstruction may also develop at times in the course of uremic states and present a difficult problem in diagnosis. Not infrequently disturbances of intestinal motility of sufficient severity to be classed as functional obstructions are observed in the very aged and in young infants. The clinical syndrome may be that of obstruction and yet no organic cause be demonstrable at operation or at autopsy. During the ten-year period 1918–1927 at the Massachusetts General Hospital 9 such cases were admitted to the surgical wards: 6 of these were patients over seventy years of age, 2 were infants under one month. Probably these functional disturbances of intestinal motility were due to the poor constitutional state of the patients; they may be difficult to distinguish from mechanical obstructions. The following histories illustrate these conditions:

CASE XXXI. *Functional obstruction in an aged person.*

No. 254687, M. G. H. Male, aged seventy-three. For the past two weeks the patient had felt poorly, but had worked until thirty-three hours before admission to the hospital. At that time he was taken with abdominal pain and vomiting. The vomitus was said to be dark in color. He had vomited a number of times since the onset of the attack; there had been one bowel movement during that time. During most of this time the patient had been troubled by hiccough.

On physical examination the abdomen was found greatly distended and tympanitic throughout. It was tender on palpation.

A diagnosis of intestinal obstruction was made and the abdomen was explored under ether anesthesia. There was no free fluid in the peritoneal cavity. The intestines were generally distended and of dark color due to interference with the circulation by distention. No cause for the obstruction could be found. During the closure of the abdomen the patient vomited and aspirated a considerable quantity of vomitus, and died immediately.

Autopsy was carried out, but no organic cause for the obstruction was found.

Comment: There is not sufficient data at hand to give an adequate explanation of the functional obstruction in this aged patient. The danger of aspiration of vomitus while under a general anesthetic and the methods of avoiding this complication are discussed in a later chapter.

CASE XXXII. *Functional obstruction in an infant.*

No. 270780, M. G. H. An infant, five weeks old. The baby had been losing weight and vomiting for four days. During this time the bowels had moved only twice and in very small amount. The baby had cried out constantly and been very restless. An enema had failed to produce either gas or feces.

General physical examination was negative except for an extreme degree of emaciation and marked abdominal distention. The abdomen was tympanitic all over. The most probable diagnosis seemed to be intestinal obstruction, and an enterostomy was decided upon.

Under local anesthesia a catheter was inserted into a distended loop of small intestine. The baby died four days later. Autopsy was essentially negative, except for distention of the small intestine, and emaciation.

SPASTIC OCCLUSIONS. So far, only those functional obstructions of the bowel brought about by intestinal atony have been considered; there are also obstructions caused by localized spasms of the intestinal musculature. Peristalsis is a complicated process, depending upon a high degree of coördi-

nation of the different parts in order to bring about a purposeful movement. If there exist areas of localized spasm that are out of time with the wave of peristalsis, the progress of the contents is blocked. While moderate degrees of intestinal spasm* are probably very common, contractions of sufficient intensity and duration to bring about the symptoms of true obstruction are rare. Authentic cases, however, have been reported, much more attention having been paid to the condition in the German literature than elsewhere.

Our knowledge as to either the frequency or the mechanism of this type of disturbance is vague. Nagel[8] reported 2 cases from his clinic, together with 49 collected from the literature. The spasms have been reported as occurring under diverse circumstances; a number have occurred in neurasthenic or hysterical individuals, who seem particularly predisposed to these spasms of intestinal musculature. The condition may be recurrent: Jacobsen[9] operated on the same patient twice during one hospital admission. Most of the cases have followed abdominal operations on the stomach, intestines or pelvic organs (Green et al.,[10] Meyer,[11] Nagel,[8] and Steindl[12]). In 1925, Reimer[13] reported 3 cases where obstruction due to localized spasm followed intraperitoneal hemorrhage. F. Colmers[14] reports 3 cases in which spastic obstruction came on in association with "grippe," the symptoms being so severe that the patients were operated upon and nothing but spasmodic contractions of the small or large intestine were found; 2 of these cases afterwards showed signs of disturbance of the central nervous system.

The views expressed by most of the authors as to the etiology are not conclusive, and the evidence on which they base their speculations is vague. Steindl[12] says that spastic occlusion can come about in several ways: as the result of injury to the peritoneal nerve plexuses; from causes directly affecting the intestinal tract; from irritation of intestinal

* The gas pains after operation probably represent, at least in part, localized spasm of the gut.

contents; as a result of hysteria; and from causes unknown. This author thinks that considerable importance should be attached to changes in the autonomic nervous system. He reports the finding at autopsy of changes in the medulla in the region of the vagus center, which he relates to the intestinal spasm. These changes, due to narcosis or absorption of toxins, consisted of perivascular infiltration and lymphocytosis. Reimer[13] considered that changes in the central nervous system are important. Riess[15] considers that spasm of the intestinal musculature is the important factor.

Local injury to the muscle or nerve plexuses is at least probably an important factor in the production of the spasm around foreign bodies in the intestinal lumen, the spasm converting an incomplete blockage by the foreign body into a complete obstruction. For example, there is good reason for believing that a spasmodic contraction often occurs around a gallstone that has lodged in the intestinal tract and that might have passed through without producing an obstruction had it not been for the tonic contraction incited by its presence. Tonic contractions have been reported around collections of intestinal parasites, particularly ascarides, of sufficient persistence to produce the syndrome of obstruction. The spasm in this instance is supposedly due to a toxin secreted by the worms (see March installment, p. 592).

The pains of lead colic are probably associated with areas of local spasm and at times may be of sufficient severity to present a problem in differential diagnosis. Murphy's[16] case in which an operation was performed in a case of lead colic under the diagnosis of intestinal obstruction is illuminating; an actual area of spasm of the intestinal musculature was found. His article carries an illustration of this condition.

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[Continued on p. 839.]

*Continued from p. 822.

Chapter XVII

FUNCTIONAL OBSTRUCTIONS (Continued)

Preventive Measures

Occasionally, under any regime, patients suffering from acute peritonitis, or convalescing from abdominal operations, will develop symptoms of functional obstruction; inhibition of intestinal motility, abdominal distention and vomiting, particularly if the peritonitis is extensive, may assume serious proportions. There are, however, certain principles of treatment that minimize the danger of this grave and distressing complication, and tend to establish a smooth convalescence. The rigor with which the measures are applied is to be governed by the seriousness of the pathological condition.

Limitation of Fluids by Mouth. In peritonitis of any extent, fibrinous adhesions glue together the coils of intestines, and the downward passage of gas and fluid from the stomach increases the intestinal distention and may thus produce obstructive kinks; the distention itself also diminishes the tone of the bowel and interferes with its circulation. Great care must therefore be taken that the stomach should not become distended with fluid and gas. In the more serious cases this means limiting the fluid intake by mouth to sips of water; or even, particularly if the patient is vomiting, prohibiting entirely the fluid intake by mouth. It should be recalled that when liquids are swallowed air also is carried into the stomach; and the work of McIver, et al.[1] showed that atmospheric air taken into the stomach by swallowing or retching is often passed down into the intestine and may be an important factor in the gaseous distention accompanying peritonitis. The fluid intake must, of course, be adequately provided for: it may be maintained by the administration of normal saline by rectum, subcutaneously or by intravenous injection (see section on Treatment). Thirst may also be alleviated by rinsing the mouth

and by keeping wet applications on the lips. If there is any suspicion that the stomach is dilated, a small stomach tube should be passed and the fluid and gas drawn off. At times it may be

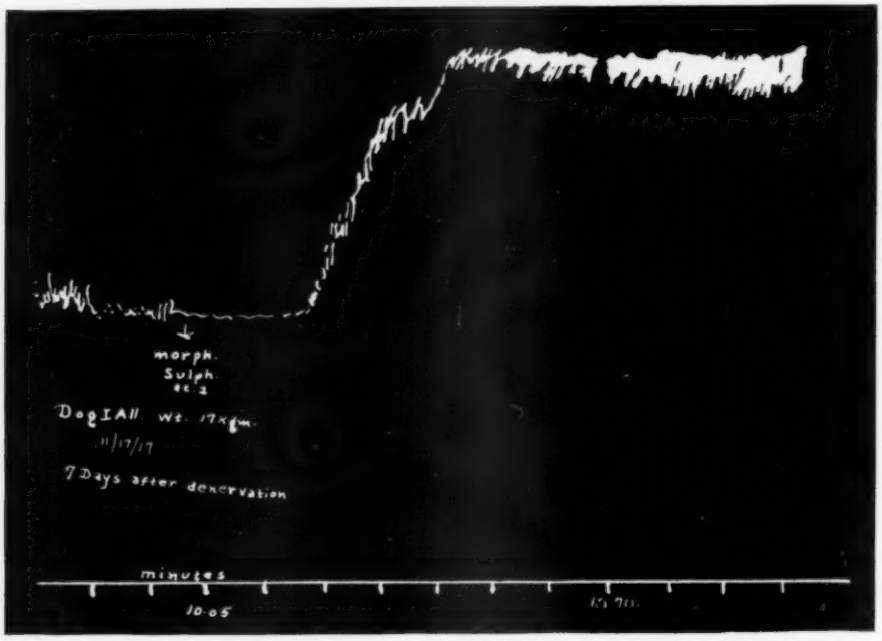

FIG. 47A.

desirable to establish constant drainage from the stomach by leaving the tube in place for twenty-four hours, or longer if indicated.

ADMINISTRATION OF MORPHINE. In those cases where peritonitis is found at operation, or where excessive trauma to the abdominal viscera is caused by operation, I believe that the liberal use of morphine is a most valuable prophylaxis against postoperative distention and functional obstruction. In certain cases of peritonitis, 10 mg. (⅙ gr.) of morphine every three hours may not be excessive, although the respiratory rate should be carefully watched and if it falls below 16 per minute the quantity or frequency of the dose should be reduced.

I realize that it is a paradox to recommend for atony of the intestine a drug that is commonly supposed to inhibit intestinal

peristalsis. The most recent work, however, has clarified the situation. Plant and Miller[2–4] in 1926 and 1928 showed, in both humans and dogs, that morphine, in the doses ordinarily

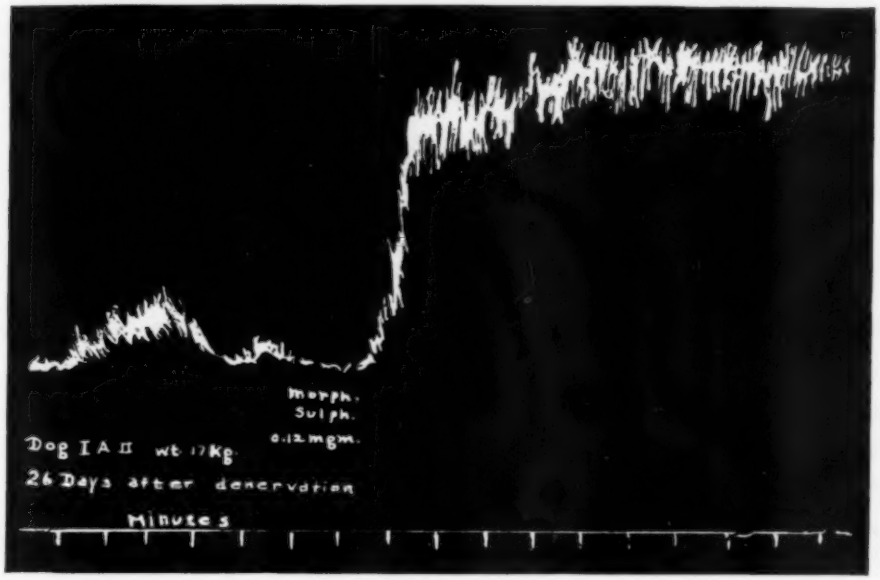

FIG. 47B.

FIG. 47. Effect of morphine on small intestine, showing marked increase in tone produced by drug. This tracing suggests that point of action of morphine is in neuromuscular mechanism in gut wall, since extrinsic nerve supply had been cut. (Denervated Thirty-Vella fistula.) Fast kymograph; time trace-minute intervals. A. Effect of 0.12 mg. morphine sulphate per kg. seven days after denervation. B. Effect of 0.12 mg. morphine sulphate per kg. twenty-six days after denervation. (After Plant and Miller[2])

used, increased the tone, and to some extent, the peristaltic activity of the small intestine and colon. (See Figs. 47 and 48.) In the case of the colon, the most pronounced effect was a marked increase in muscle tone, which might last for several hours after the administration of 10 mg. of morphine. In contrast with its effect on the intestine, morphine caused a decrease in the muscle tone of the stomach wall. These studies by Plant and Miller were reviewed in the *Journal of the American Medical Association*, but they did not appear in a surgical journal and have apparently been overlooked in the surgical literature. Those who are accustomed to think of the action

of morphine on the intestinal tract as purely inhibitory, would do well to look up this work; it is quite convincing. The observations of Weiss and Davis,[5] Gruber et al.,[6,7] and Dvorak

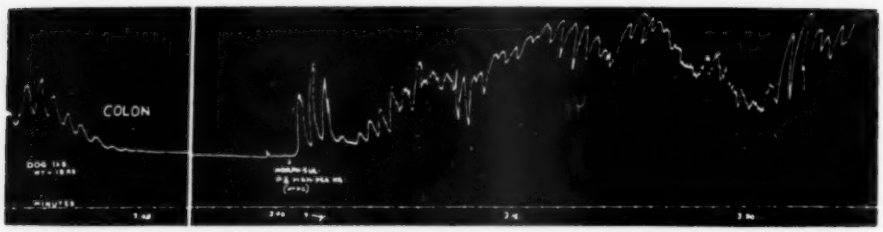

FIG. 48. Effect of morphine on colon, drug causing both an increase in muscle tone and in peristaltic activity. (After Plant and Miller[3])

et al.,[8] confirm the work. Clinically, I have repeatedly seen patients with extensive peritonitis who after receiving repeated doses of morphine passed considerable flatus within twelve to twenty-four hours after operation; and the use of the drug definitely appeared to prevent the appearance of serious distention and lessen the likelihood of obstructive symptoms.* In my article on postoperative distention published in 1926,[1] I was not familiar with this work of Plant and Miller, and gave the commonly accepted explanation of the favorable effect of morphine in peritonitis, namely, that it quieted the intestinal movements, and prevented the spread of the infection, "splinting the intestines"; I now believe that the best explanation of its beneficial action in combating the distention accompanying peritonitis is that it increases the tone of the small intestine and colon.

Is there danger of masking the symptoms of true mechanical obstruction arising after operation by the use of morphine? Where the drug is used intelligently, under the supervision of an experienced surgeon, I do not believe that the danger is

* Historically the use of morphine in intestinal obstructions and peritonitis is of considerable interest. Before the days of abdominal surgery the early writers were enthusiastic over the use of morphine in intestinal obstructions (Brinton,[9] Leichtenstern,[10] Thomas,[11] and Nothnagel,[12]) and they seemed undoubtedly to have often prolonged life, and at times, perhaps, effected a cure by the use of the drug. Their cases must have represented all types of obstruction, both organic and functional. Fifty years ago Alonzo Clark[13] was a strong advocate of large doses of morphine in peritonitis.

great. The peristaltic movements above a point of obstruction are not abolished by the administration of reasonable doses of opiates.[8,14] It is true that if used in too large doses it will minimize the symptom of pain; but if colicky pain is a striking symptom, of course care would be used in continuing the drug. Persistent vomiting, distention and evidence of hyperperistalsis on inspection or auscultation indicate the need for operative interference (see value of enterostomy in peritonitis*).

Use of Cathartics. The use of cathartics is contra-indicated in the presence of any obstructive symptoms. If there is any mechanical element in the obstruction, forcing the bowel contents downward is likely to convert a partial into a complete obstruction. Other dangers in the use of purgatives in the presence of obstructive symptoms were forcibly stated by Barlow[15] about 100 years ago.†

Pituitrin and Eserin. In general, drugs such as pituitrin and eserin, that have a tendency to set up violent types of peristalsis and to cause localized spasms of the intestine, should be avoided; they are often either totally ineffective, or, if they set up temporary peristalsis, the later effect may be a more complete relaxation of the intestinal musculature.[1,16]

Enemas. An occasional low enema is useful in getting rid of accumulations of gas in the colon. A free movement of the bowels is not so important, provided the patient is passing flatus and not becoming distended[1]; and a too frequent use of enemas is to be avoided, particularly if they are not being freely expelled. An important function of the colon is to dehydrate the feces, and if the colon is being constantly filled with watery solutions that are not freely expelled, it seems likely that fermentation is increased. Small enemas containing

* This will appear in a later issue.

† Barlow writes[15]: "But I believe that it is not so generally considered that active purgatives may produce serious mischief, even when they do *not* invert the action of the tube, and when they *do* reach the seat of the obstruction; whereas it is evident that in the case of George J—— any forcible effort to propel the contents of the bowel beyond the seat of obstruction must have been productive of much irritation immediately above it, and have increased the risk of laceration."

glycerine and magnesium sulphate frequently give satisfactory results.*

APPLICATIONS OF HEAT TO THE STOMACH. Flaxseed poultices on the abdomen, combined with a rectal tube and a dose of morphine, are often an exceedingly effective and harmless method of getting rid of flatus and reducing distention.

POSITION OF THE PATIENT. If peritonitis is present, Fowler's position seems useful in localizing the infection in the lower abdomen and diminishing toxic absorption.

SUMMARY. In summary, it may be said that symptoms of functional obstruction are best prevented by measures tending to avoid or relieve distention: limitation of the fluid intake by mouth; liberal administration of morphine, which increases the tone of the small intestine and colon and the use of flaxseed poultices on the abdomen, rectal tube and occasional enemas. Cathartics should be avoided; and, in general, the use of pituitrin and eserin likewise.

In connection with the management of cases showing symptoms of functional obstruction, the sections on the treatment of early postoperative obstruction and on the value of enterostomy in peritonitis should be consulted.

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